Heating and Ventilating

For Engineers and Contractors Controlling the Design, Specification, Installation and Maintenance of Heating, Ventilating and Air Conditioning

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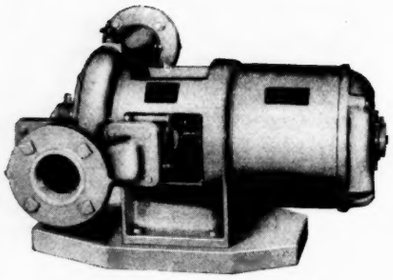

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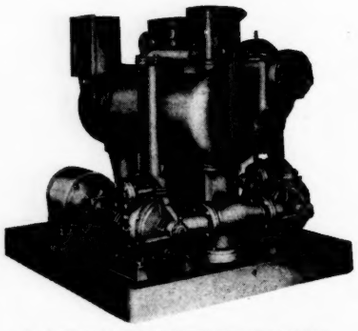

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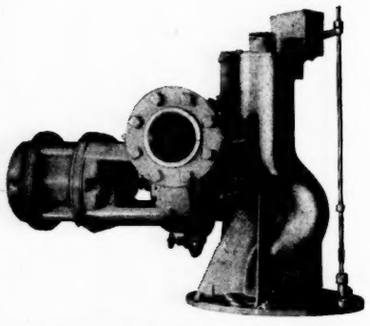

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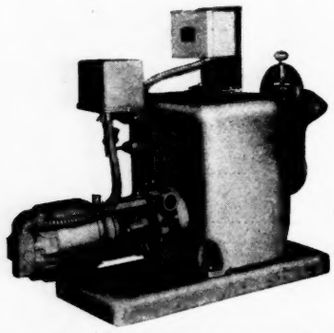

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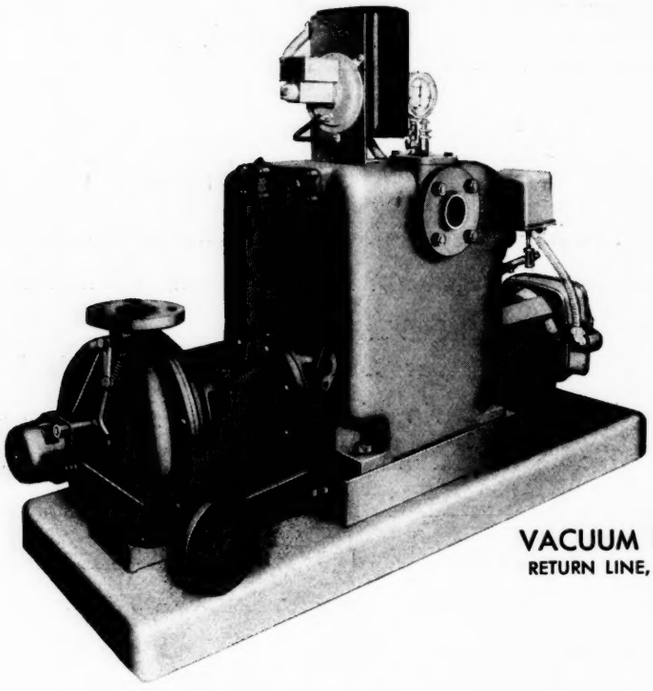

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The Jennings Vapor Turbine Return Line Vacuum Heating Pump shown at the top of this page is a new member of the Nash family. Here is a pump which eliminates electric current, the one largest cost item in the operation of a heating pump.

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Bulletin 203 gives some interesting details concerning this economical and efficient pumping unit. Why not send for your copy?

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Air Conditioning—Cleaning the Air

AIR cleaning is now in as much demand as was humidification a few years ago. It has come to be an essential part of getting air ready for use. Its growth in favor is largely the result of suitable filters having become available. It is not possible to go into all phases of air cleaning at one time, and the present purpose is to outline some of the features to be found in the air-cleaning equipment now on the market. The subjects given attention are the present standards of practical air cleanliness, an outline of the principles used, the types of filter materials used as filtering media, methods of servicing, and arrangements used for placing filters in ducts.

Standards of Air Cleanliness

Turning attention first to standards of cleanliness we find that such standards for ventilation air have never been set up on a theoretically correct basis. The reason is that there is as yet no really scientific way of evaluating all the factors because their exact effects are not known.

The lack of information has not prevented the use of air cleaning reaching a high state of development as a practical matter for, while waiting for more exact information, a workable set of standards has come into existence. Necessarily, these have had to be built up on practical applications and it is significant that the standards of air cleanliness now demanded and secured in numerous installations are measurably higher than they were even 10 years ago. Improved results have naturally been obtained only as better materials and designs have developed.

As a practical standard is now fairly well fixed it is essential that its nature be understood, and a brief review of the general reasoning behind it is worth noting.

It has grown up as a result of the answer obtained to the practical question, "Just what does this matter of dust and dirt in the air resolve itself into as we encounter it in the air used in heating and ventilating plants?"

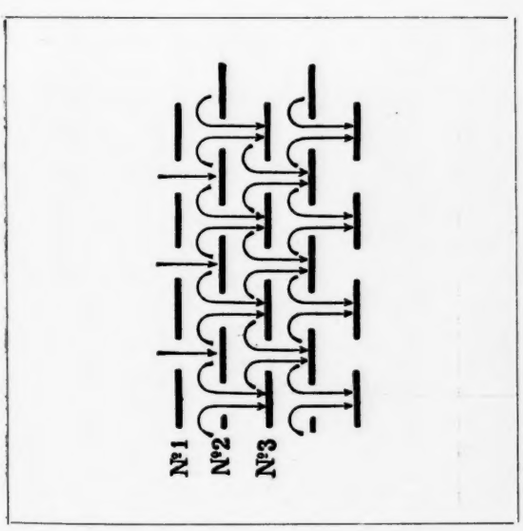
As these installations are commonly intended to make the air suitable for the use of the people in the building the consideration of the effects of dirty air on them is the one of greatest importance in the most common case.

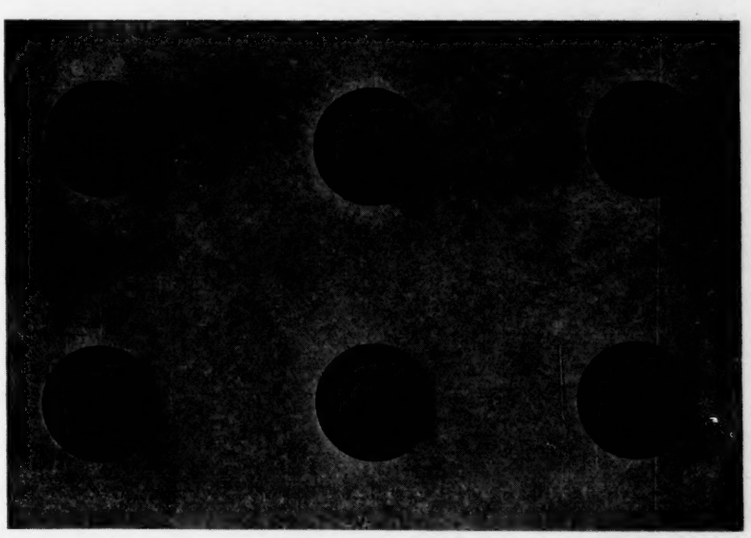
This being so, the question really becomes, "How clean and free from dust and dirt must the air be to be suitable for use by people?" This innocent question is still troublesome for there is no answer to it in directly measurable terms. Consequently, as a practical move, we have to outline the answer in terms of the effects desired and those obtainable, together with the cost involved.

The desirable effect would be to remove the dust with such completeness that any remaining will not be detrimental. The accepted present view, and a sensible one, is that while the air is being cleaned to the point of being acceptable to the humans it might also just as well be made harmless to the building and its furnishings.

In order not to be detrimental to the building or furnishings all the dust of such size that it will settle out of the air and gather on walls or furnishings should be removed. Dust which is so fine that it floats in the air will not deposit on the surroundings to any extent. The limiting size can be computed, but it is sufficient to note that such dust particles are exceedingly fine and light.

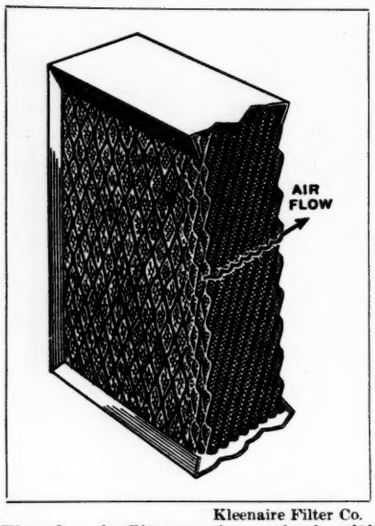
On the angle of detrimental effects on people, computations get nowhere since the limiting size of particles which are harmful is unknown. Consequently, there is little to go by. What is known is that some dust particles do have bad effects and that dust particles are carriers of certain harmful bacteria. These known facts build up a supposition that the removal of all except very fine dust is at least desirable.





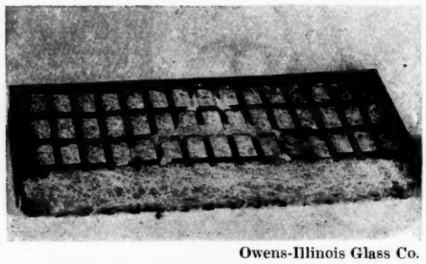
American Blower Corp.

Fig. 1. (Left) The change-of direction principle. Flat metal plates, Fig. 2 (Right), are drilled and arranged so that the air current strikes the plates head on, the resulting change of direction throwing out the dirt particles.



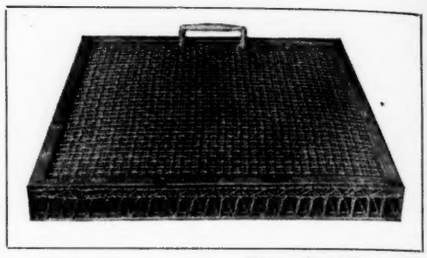
Kleenaire Filter Co.

Fig. 3. A filter unit packed with woven-wire plates, removing the dust by centrifugal action, impingement, and cohesion of dust.



Owens-Illinois Glass Co.

Fig. 4. A light-weight unit using glass wool as the filtering material. The wool is coated with a solid adhesive substance.



Greene Gas Cleaner Co.

Fig. 5. A dry filter made of layers of coarse jute spaced by wire screen and wool fabric.

All these considerations lead to the commonly accepted conclusion that complete removal of dust cannot be shown to be positively necessary in heating and ventilating work and that a satisfactory standard of practical performance is the removal of all but very fine particles.

With the mark to be aimed at clear, we can now examine the side of the performance obtainable. If enough precautions are taken it is possible to approach complete removal. As the ultimate particles are removed, though, the cost increases rapidly. With these points in mind the whole problem of commercially feasible dust removal from ventilation air can now be simply stated. It is, to remove enough dust so that it will not be a nuisance or a menace and to accomplish it at a cost which will make the necessary installation attractive.

Fortunately, there are some credit items of cost to be taken into account. In buildings, as the dust is removed from the air the cost of cleaning, laundry, replacement of furnishings, and redecoration of walls is definitely reduced. The credit to these items varies with the dustiness of the original air but in many localities the saving is great enough to justify the equipment cost of using commercial dust removers capable of approaching removal of all the dust. The result is that the commercial standard is to aim at taking out nearly all the dust.

Air-Cleaning Principles

Knowing in general terms the objective to be aimed at the next question is, "How does the available apparatus go about it?" While many ways have been tried, and used to some extent, there are four of present interest.

1—Passing the dirty air stream through a water spray. This causes those dust particles which come in contact with drops of water to be made wet, and heavier, and to drop out of the air stream along with the water droplets.

2—Causing the dirty air to change its direction abruptly with the idea of throwing the dust particles out of the stream.

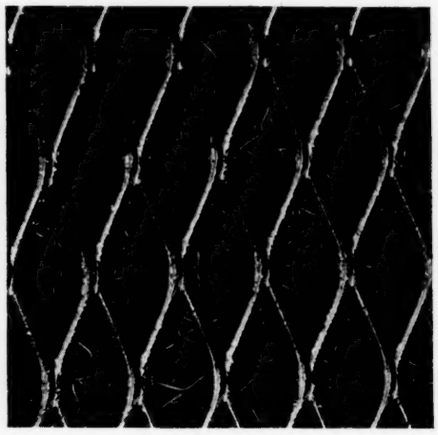
3—Causing the dirty air to strike against sticky or adhesive surfaces which will catch the dust particles and hold them.

4—Passing the dirty air stream through a finely woven screen of fabric or similar material, usually textile, which catches the dirt particles at the surface and refuses to let them pass through.

Virtually all the dust-separating equipment now available for ventilation work uses one or more of these methods.

A number of descriptive words have come into use in connection with these kinds of equipment. Two of them are *wet* and *dry*. Those cleaners which use sprays are sometimes called *wet*, while those which use the other three methods are called *dry*. Obviously, these words mean little, for combinations of methods are used and also those using adhesive substances are wet when liquid adhesives are used.

An air washer equipped with scrubber or eliminator plates is a good illustration of a cleaner using the water-spray principle. It is really a combination device for the plates are so arranged that they change the direction of the air stream while the plates, being wet, act as dust holders. The change-of-direction principle most often appears in combination with others in ventilation work, but is often used alone in industrial dust collection and recovery. The adhesive surface idea is of comparatively recent popularity and is perhaps best known where oil is the adhesive used.



American Air Filter Co., Inc.

Fig. 6. (Left) Close-up of dry filter using galvanized crimped wire as the filter medium. Fig. 7. (Right) Close-up of dry filter using expanded metal as the filter medium.

Fiber or fabric filters are said to be the oldest in point of time. After falling into disuse this principle has been revived in late years.

Types of Air-Cleaning Apparatus

Air-cleaning apparatus used in our work makes use of the several principles just outlined in many ways, and because of this a classification by the principles is not adequately descriptive. There seems to be no really logical method of dividing the apparatus into a few types and assigning names to them. Instead, the description of types has to follow along lines of using the words which have come into use with the apparatus.

The washer type of air cleaner has advantages in that it contains a ready means of adding moisture to the air or extracting moisture from it, with a method of cleaning. It does not build up a resistance to air flow, as the cleaning is continuous by flushing the scrubbing plates. A disadvantage urged against its use as a cleaner is that it does not remove some kinds of dust. As the washer is so well known it seems unnecessary to discuss it further.

The other cleaning devices, and the ones which we will now consider, make use of all the principles listed and in many cases make use of several of them at once. The word "filter" has come to be applied to them and usually, too, they are referred to as "dry" although, as mentioned, they are not all actually dry when in use.

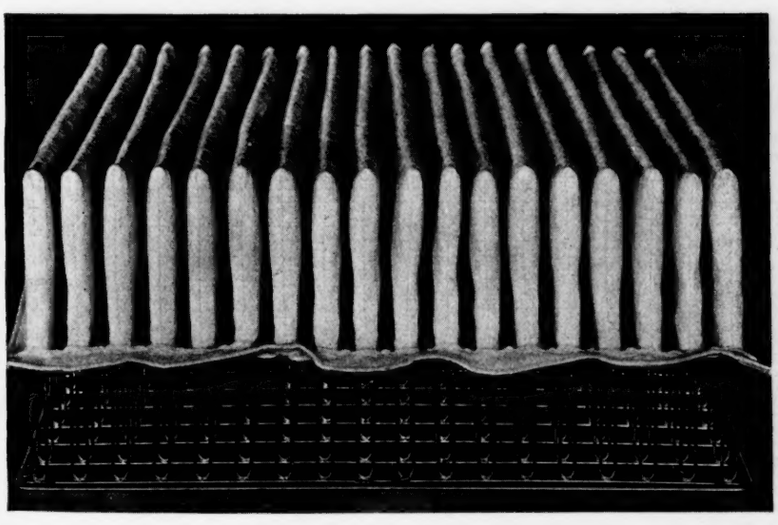
One of their chief characteristics is the application of the unit idea to them. All are built by factory production methods and in order to make a reasonably small number of sizes fit large or small installations they are so built that few or many of these units can be applied as necessary. The size of the unit and its physical appearance are controlled by the materials used and the methods of cleaning used with them. Heavy floor-mounted units are necessary where the filter material is built into a revolving belt. Figs 12 and 14 are examples of units of this kind. The units are available in stock sizes in a few widths and a considerable number of heights. A style which will fit the available headroom is selected and then enough units of this height are used side by side to take care of the quantity of air to be handled. The other style of unit is usually small in size, and stacks may be built up by placing these units in frames with any number of units high and wide, using enough units to handle the air quantity. Figs. 3, 8, 13, 17, and 19 are examples. The unit idea has been instrumental in bringing down costs, adding to convenience of design, aiding assembly in the field, and can be credited with doing much to promote the use of dry filters.

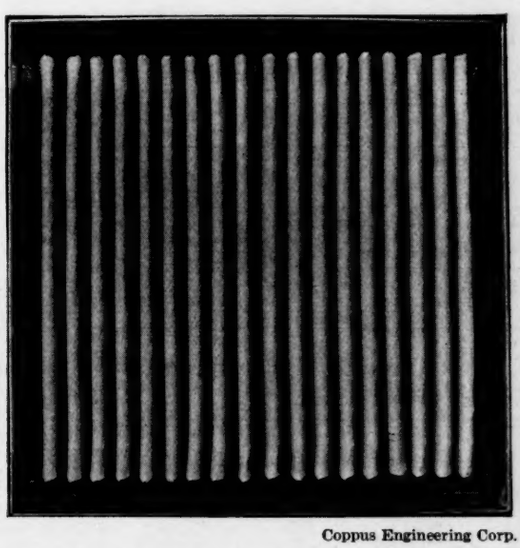
The floor-mounted units using belts are termed continuous-cleaning, or continuous-type filters. The others must usually be cleaned occasionally or as their condition requires. Methods used in cleaning and servicing are taken up later on in this article. At this point it is merely necessary to call attention to the distinction between the types.

Filter Materials

The filter material used must necessarily depend on the air-cleaning principle. In describing them it is more convenient to take up the materials used by continuous filters separately from those used by the intermittently-cleaned ones instead of basing a description on the principle of air cleaning.

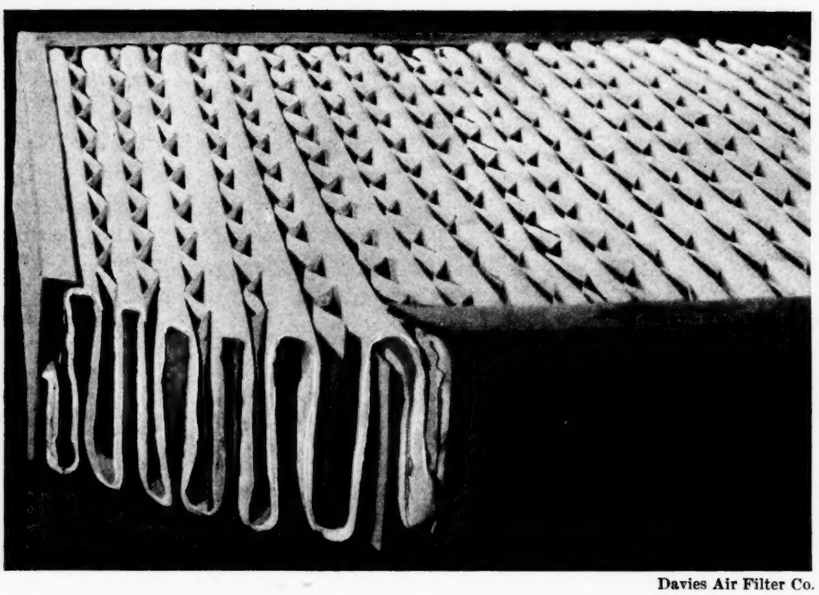
One continuous filter uses woven-wire plates which are corrugated and on which bakelite and fiber are baked. These plates are mounted on vertical chains set on wheels and are so arranged that the lower plates dip into an oil bath. A metal jacket surrounds this assembly. The bath catches the dirt from the plates and as they rise out of the oil they are coated with this material and are ready to act as clean surfaces covered with a viscous material against which the air stream impinges. Others use screens of metal plates, while one uses a screen of woven wire. All except one dip into an oil bath. These filters are characteristically auto-





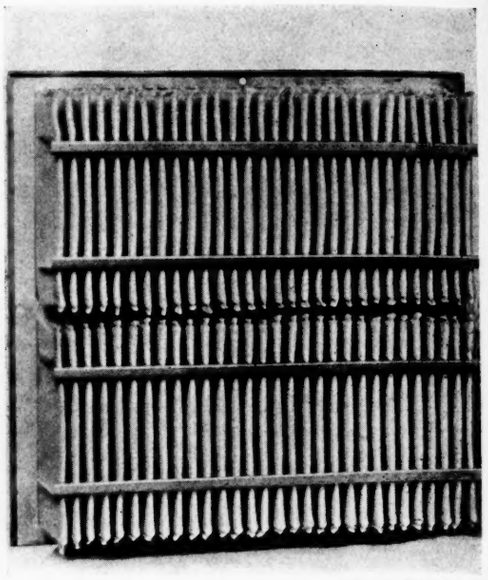
Coppus Engineering Corp.

Fig. 8. (Left) Fabric filter embodying the pocketing principle. The filter medium is felt, which is slipped over a wire frame. Fig. 9. (Right) Looking at the filter in the direction of air flow.



Davies Air Filter Co.

Fig. 10. Material in this unit is folded in and out over spacers. The cotton fabric material is thrown away when dirty.



Staynew Filter Corp.

Fig. 11. A pocketing-type filter with a felt material which is cleaned by vacuum.

matically driven, under control of a timing device. Figs. 12 and 14 are examples of these filters and illustrate the nature of the materials used as well as giving an idea of arrangement.

Other illustrations show materials in enough detail to make their nature clear. Thus, Fig. 4 shows a cross-section though a light-weight unit in which the material is a glass wool. This is placed in the grid framework shown, with coarse material on the entering air side and with denser material on the leaving side. The wool is coated with a solid adhesive substance. Fig. 24 shows this filter unit placed in its supporting metal framework. Fig. 6 is a close-up view of a filter which uses galvanized crimped wire as the filter medium, while Fig. 7 shows one of like character using expanded metal as the medium. Both of these are built up as units on metal frames for inserting into supporting boxes or framework. They use oil as an adhesive coating on the medium which is placed with graded density of fill, providing coarse material on the entering air side and denser material on the leaving side. A better view is shown in Fig. 18 from which the appearance of the units may be noted.

In filters making use of the adhesive impingement principle it is essential that the arrangement shall cause as many of the dust particles as possible to strike the adhesive-covered surfaces. It is also desirable that the air stream be broken up in order to aid this process. Space for the entrained dust is also desirable unless the filter can be cleaned at frequent intervals.

Fig. 5 shows a unit, not of the impingement type, which uses an air maize. Its medium is a coarsely-woven fabric so arranged that the stream is broken up and turned in various directions as it passes through.

Fig. 3 shows a unit built up of corrugated woven-wire plates, enamel waterproofed, and packed between expanded metal guards.

Figs. 1 and 2 illustrate a unit making use of the change-of-direction principle largely. Here flat metal plates are so drilled and arranged that the air stream is broken up and currents strike the plates head-on causing an abrupt change in direction of flow.

Materials used in those filters which pass the air through a finely-woven textile or fabric screen are diverse. Felts are popular. Materials which have a smooth surface on one side and a fluffy surface on the other are common. Paper is in use, as are combinations of wire cloth and textiles.

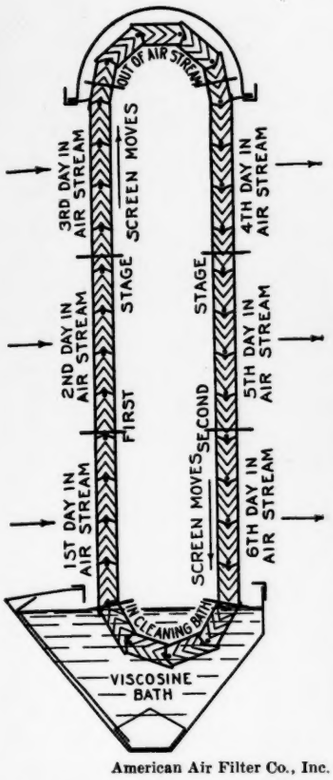
When these filters were originally used the practice was to stretch the material on a frame placed in the path of the dirty air. They clogged quickly and either eventually let the dust find its way through, or else soon offered such resistance to air flow as to cut down quantities seriously and interfere with operation. The present filters using these materials are so built that the material is pocketed or else is swung back and forth on a frame. This permits presenting a large surface to the air flow (see Fig. 22). Use of this idea seems to be the key to successful application of fine-woven screens to air cleaning. Figs. 8, 9 and 11, illustrate the application of the pocketing idea. Fig. 10 shows a unit in which the material is folded in and out over spacers. In Fig. 16 is shown one of these filters in which the material is laid back and forth on a series of wire screens. Fig. 19 shows this filter assembled and the pocketing of the material is clearly visible.

Fig. 8 shows a unit in which the filtering medium is felt. This is first shaped and then slipped over a wire frame. In Fig. 13 units of this kind are in place in their supporting framework. The one in Fig. 10 uses a cotton material, while that in Fig. 11 is felt. Fig. 15 shows an installation with a filter having jute and cheese-cloth as the medium. The filtering material in the unit shown in Figs. 16 and 19 is a cellulose product intermediate between paper and cloth.

Servicing Filters

One of the important considerations in making use of filters for heating and ventilating work is the ques-

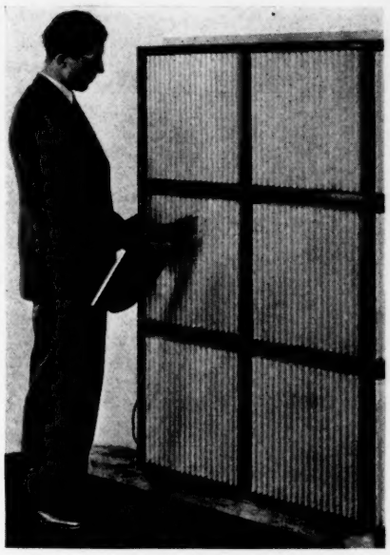
SERVICING THE FILTER



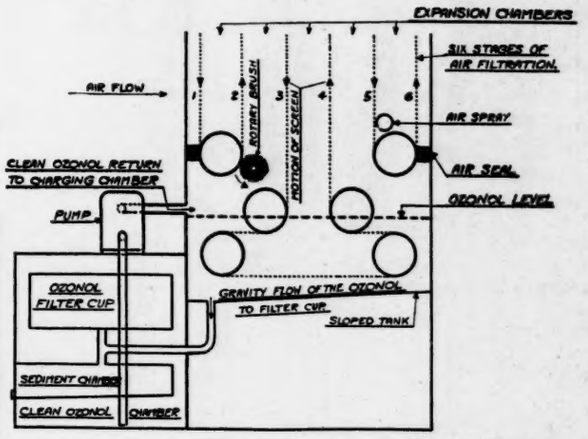
American Air Filter Co., Inc.

Fig. 12. (Above) The filtering medium moves through a bath, thus being self-cleaning. Sludge is removed at the bottom every two or three months.

Fig. 13. (Below) A portable vacuum cleaner removes the dirt from this dry-type filter.



Coppus Engineering Corp.

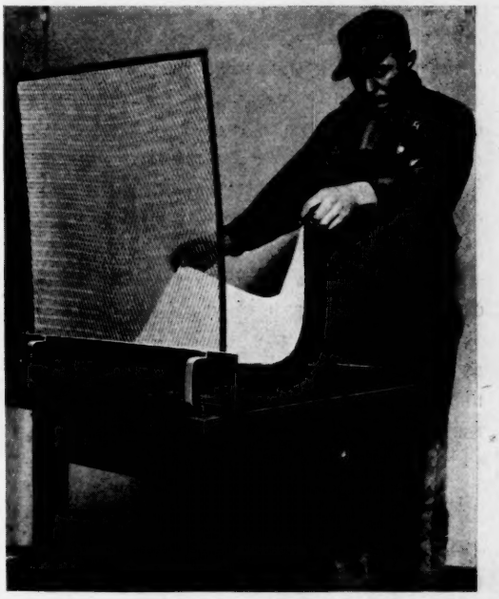


Burt Air Filter Corp.

Fig. 14. (Above) The filtering screen is cleaned by an air spray, a rotary brush, and by a viscous charging agent.

Burt Air Filter Corp.

Fig. 15. (Above) A jute and cheese-cloth filter cleaned with a portable vacuum cleaner.



American Air Filter Co., Inc

Fig. 16. (Above) A dry-type filter with a 6-ply mat medium, which is discarded when dirty and replaced as shown.

Fig. 17. (Below) These glass-wool units, including their frame, are discarded and replaced.

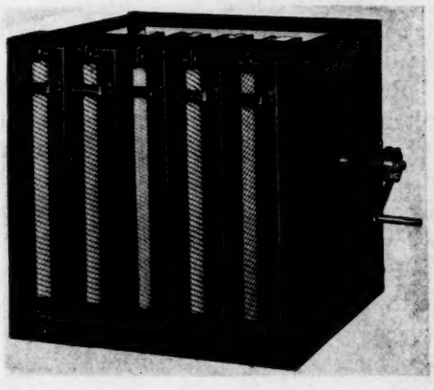
Owens-Illinois Glass Co.

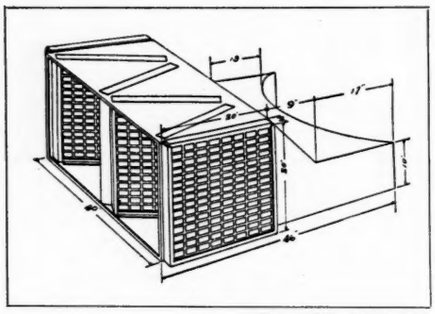
Fig. 18. (Below) A unit type filter which is cleaned in a steam bath in a few minutes.

American Air Filter Co., Inc.

Fig. 19. (Below) When the handle of this unit is turned a snapping action vibrates the units, throwing off the dirt.

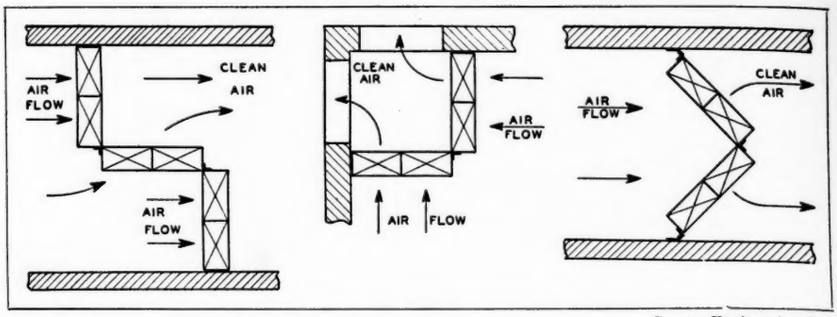
American Air Filter Co., Inc.





Owens-Illinois Glass Co.

Fig. 20. Zig-zagging permits exposing a large amount of filter surface to the air stream.



Coppus Engineering Corp.

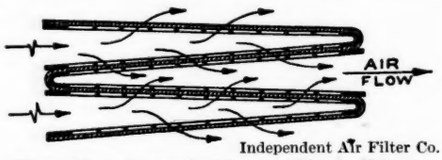
Fig. 21. Alternate methods of arranging filter units to secure the maximum amount of surface.

tion of service. Like all equipment they require that some attention be paid to them if they are to operate with the expected results.

Whether the amount of such attention is great or small depends not only on the care with which they are erected but upon the nature of the job in which they are installed and on the nature of the filter itself. In handling extremely dirty air it would naturally follow that more operating attention would be necessary than when the incoming air is relatively clean. Some filters naturally need more attention than others because of the kind of material used in their construction and the principle of air cleaning applied. In selecting filters, therefore, first cost should not be the only factor considered. Operating and maintenance costs must be given weight. A number of methods of cleaning and servicing have been developed and estimates of annual cost with each can be readily made.

Before noting the methods in use it is necessary to recall that resistance to air flow is the operating factor most closely related to the question of servicing. If resistance to flow were not dependent on the condition of the filters, the servicing would be by no means as important a consideration as it is. A brief statement of the relationship is therefore in order.

Since horsepower varies as a power of the resistance to flow, it is important to keep resistance low in order that operating expense be kept down. Since also the total resistance to air flow through a whole system of ducts is often only a small amount, the actual resistance through the filter itself must be made small if it is not to be accountable for a disproportionate share of the total resistance. In the commercial filter this resolves itself into keeping the operating resistance to a fractional part of an inch of water.



Independent Air Filter Co.

Fig. 22. A pocket-type filter with a maximum of surface in a small space.

Resistance to flow depends on the nature of the filtering material and on the speed with which the air stream passes through. If air is passed rapidly through a given filter the resistance to flow increases rapidly. Conversely, the resistance may be cut down by using a lower velocity. As the velocity is decreased the area of filtering material is increased. The whole problem is to find a combination of these inter-related variables which will not build up too great a resistance to be economical in operation and at the same time not be so low that the size and first cost of the filter will be prohibitive. While this balance is being achieved the construction and dimensions must still be such that the filter will really remove the dirt.

In the filters as they actually are available the resistance to flow when operating clean is stated by their makers to be from about 3/8 in. of water to 1/12 in. of water.

Resistance to flow at a fixed velocity of air with a clean filter does not tell the whole story for the resistance builds up with use unless something is done to prevent it. In the continuous-cleaning type something is done all the time. In others something may be done continuously by cleaning or replacing a certain number of units each day—enough to keep the total resistance down—or cleaning may be done periodically by letting the resistance build up to a fixed maximum and then giving attention to it. Both methods are used, the former usually in large installations and the latter in small ones.

Consideration of the cleaning methods in use shows that they can be grouped into two major classes. The classification on this basis follows:

(a) Removing the dirt from the filter.

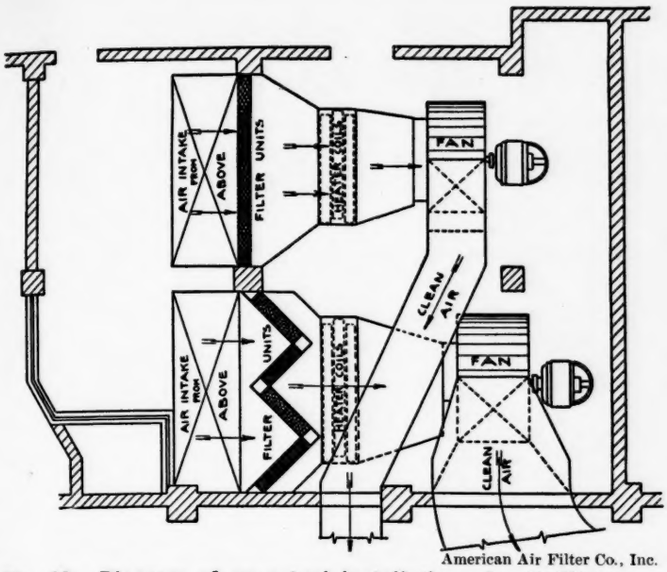
1—By continuous methods (automatic if desired) such as building the filter so that the dirty parts can be rotated past a brush, vacuum cleaner, nozzle, or through a liquid bath; or by flushing the dirty surface with water or oil.

2—By periodic cleaning of parts or of whole device as necessary, by taking out sections and removing dirt by rapping, vacuum, boiling in cleaning solution, dipping, etc.

(b) Removing both dirt and cleaning element; by disposing of the element, dirt and all, when it becomes clogged and replacing by an entirely new element.

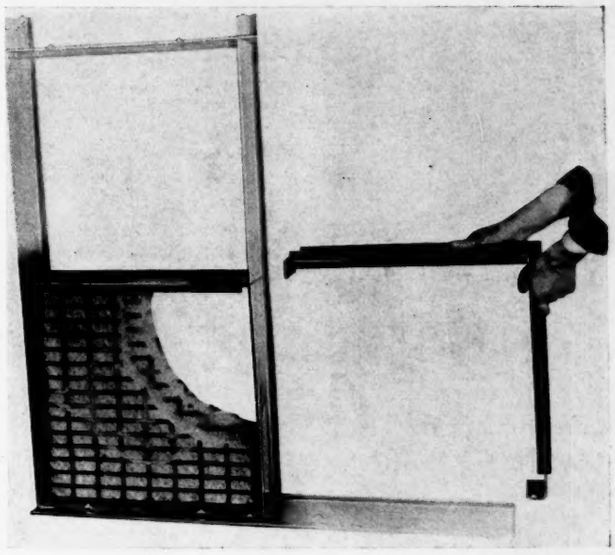
The first method is that used in the continuous filters. They are so arranged that not only may the dust disposal be continuous but the ventilating plant need not be shut down while cleaning is going on. Figs. 12 and 14 are examples of filters arranged for this type of cleaning. They require little attention beyond replenishing the oil.

Figs. 13 and 15 show the use of hand vacuum cleaners, in each case without removing the filters from their framework. In Fig. 19 the unit is provided with a hand-operated crank which, when turned, raps the units and jars the dirt loose. Other hand-rapping



American Air Filter Co., Inc.

Fig. 23. Diagram of an actual installation of unit filters, showing both straight line and staggered arrangement of unit filters.



Owens-Illinois Glass Co.

Fig. 24. Frame units being erected for a glass-wool type of unit filter.

methods to dislodge the dirt are in use, such as providing a box to catch the dirt and a paddle for tapping the element. In Fig. 18 is a tank specially built for renovating oil-coated filters. After removal from the tank they are again dipped in oil and replaced in position in the installation. Fig. 16 illustrates a replacement method in which the filter material is renewed when necessary. Fig. 17 shows clearly a method of servicing where the dirty elements are replaced and disposed of entirely. The dirty filters are in the box at the front of the illustration while the clean ones are on the floor. The dirty filters still to be removed can be readily recognized.

Arrangement in Ducts

The unit idea facilitates making installations, as already noted. The preferred method is to locate the bank of units in line across the path of the air flow, but space can be gained by a zig-zag arrangement or by offsetting. Fig. 23 illustrates both of these arrangements side by side. Fig. 21 suggests other alternative layouts. Arrangement in series is also sometimes desirable.

In addition to being available as single units, filters can be obtained boxed in sheet-metal enclosures, as shown in Fig. 20. These are especially favored in small installations. These boxes are usually equipped with access doors and channels. The filters can be slid out for servicing. Similar arrangements are made where filters are used in heating or cooling cabinets placed directly in a room.

Sizes and Capacities

Determination of size and capacity for a given filter from rating data of the manufacturers is extremely easy, involving nothing more than a simple division of the quantity of air by the quantity which each unit passes at rated conditions.

Do You Know the Answers?

OF course you know what the terms given below are. Many of them you either talk or read about every week in connection with your work. Suppose, though, that you found it necessary to define each of them in simple terms for someone else, so that from your definition they could distinguish between such similar terms as, for example, unit heater and unit ventilator. Try this, and possibly you will be surprised how difficult it is to put your knowledge into words that will satisfy you.

Ton of refrigeration
static pressure
kata thermometer
fusible plug
Hartford loop
orifice
extended surface
pitot tube
ejector
unit heater
wet bulb temperature
coefficient of conductivity
louver
grate area
induced draft
radiant heating
psychrometry
direct current
propeller fan
register
round boiler
primary air
bucket trap
total heat
hygroscopic element
malleable fitting
check valve
downfeed
streamline
insulation
convector
evaporative cooling
economizer
reducer
air washer
floor plate

The Determination of Sun Effect on Summer Cooling Loads

By G. A. HENDRICKSON† and J. H. WALKER‡

THE computation of the cooling load added to an air conditioning unit by solar radiation requires a determination of the radiation intensity, the unshaded transmitting area, and the transmission coefficient of the transmitting surface. A previous article[1] gave information and extensive data for determining the intensity relative to horizontal planes and to vertical planes of any orientation when the intensity for normal incidence is known. Atmospheric transmission, which determines the normal intensity, was not treated in detail, and no mention was made of methods for taking into account the effect of partial shading of the glass. The transmission coefficient of glass was given only for normal incidence.

The present article treats each of these items in greater detail. The existing data on atmospheric transmission are condensed into a workable method for estimating the radiation intensity when pyrheliometric measurements are not available. A method is developed for finding the effect of partial shading of windows by projections of the building and by adjacent buildings. Finally, data are given for a determination of the proportion of the incident energy transmitted through glass and the amount returned to the atmosphere by reflection.

Atmospheric Transmission

Atmospheric transmission is affected by three major items: dry air traversed, atmospheric moisture traversed, and dust particles encountered. All of these vary greatly with the location, and with time. The dry air traversed depends on the solar altitude and the barometric pressure; the atmospheric moisture traversed depends principally on the partial vapor pressure, and the dust encountered depends on local conditions. The effect of dry air and moisture at a given location on clear days is fairly regular and can be calculated from existing data if the partial vapor pressures or wet bulb temperatures are known over a considerable period of time. With these data the atmospheric moisture can be determined by the following relation due to Julius Hann:

$$w = 5.85\ p_v\ 10^{-\frac{e}{72{,}200}} \qquad (1)$$

Also the dry air traversed is determined by the relation,

$$m = \operatorname{Csc} \theta \qquad (2)$$

where

- w = atmospheric moisture in centimeters of water if precipitated to the earth's surface.
- p_v = average partial pressure of water vapor in inches of mercury determinable from the wet bulb temperature.
- e = elevation above sea level, feet.
- m = air mass traversed referred to one atmosphere at vertical incidence as unity.
- θ = angular altitude of the sun above the horizon; note that $\operatorname{Csc} \theta = 1 \div K_h$.
- K_h = cosine of the angle between the sun's rays and a vertical line, as tabulated in the previous article.

The values of w and m given by these equations may be used to determine the transmission coefficient of dust-free air from the accompanying diagram[2], Fig. 1. The curves of this diagram are computed for an atmospheric pressure of 29.92 in. of mercury. For a lower atmospheric pressure, B, inches of mercury, the air traversed scale, m_o, is increased by the ratio $29.92 \div B$ and the water content of the atmosphere indicated for each curve is reduced by the ratio $B \div 29.92$.

The depletion by dust must be estimated. The following data, representing averages of intermittent readings for a year, are offered as a guide.

Location	Washington, D. C.	Madison, Wis.	Lincoln, Neb.
Depletion by dust, in % of the intensity outside the atmosphere			
with 1 atmosphere ($m = 1$)	9	6	4
with 2 atmospheres ($m = 2$)	12	8	6

These data indicate that a dust cloud extending almost as high as its lateral dimensions hangs over cities and industrial centers. In consequence, as the sun drops nearer the horizon, the dust encountered does not increase as fast as the air traversed increases, and the depletion by dust is not proportional to m. Consideration should also be given to the possibility of a directional quality in the dust depletion characteristic. If the location is in the edge of a region affected by a large industrial center the depletion may be considerable during a part of the day and less marked at other times.

Since a city's industrial activity and its weather conditions determine the amount of dust present in the atmosphere, a consideration of these factors will

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‡Superintendent of Central Heating, The Detroit Edison Company.

[1] "Summer Cooling for Comfort as Affected by Solar Radiation," by G. A. Hendrickson and J. H. Walker, HEATING AND VENTILATING, November, 1932, page 14.

[2] This diagram is reproduced from data in the National Research Council Bulletin 79, page 39. Values are given with greater detail in that bulletin.

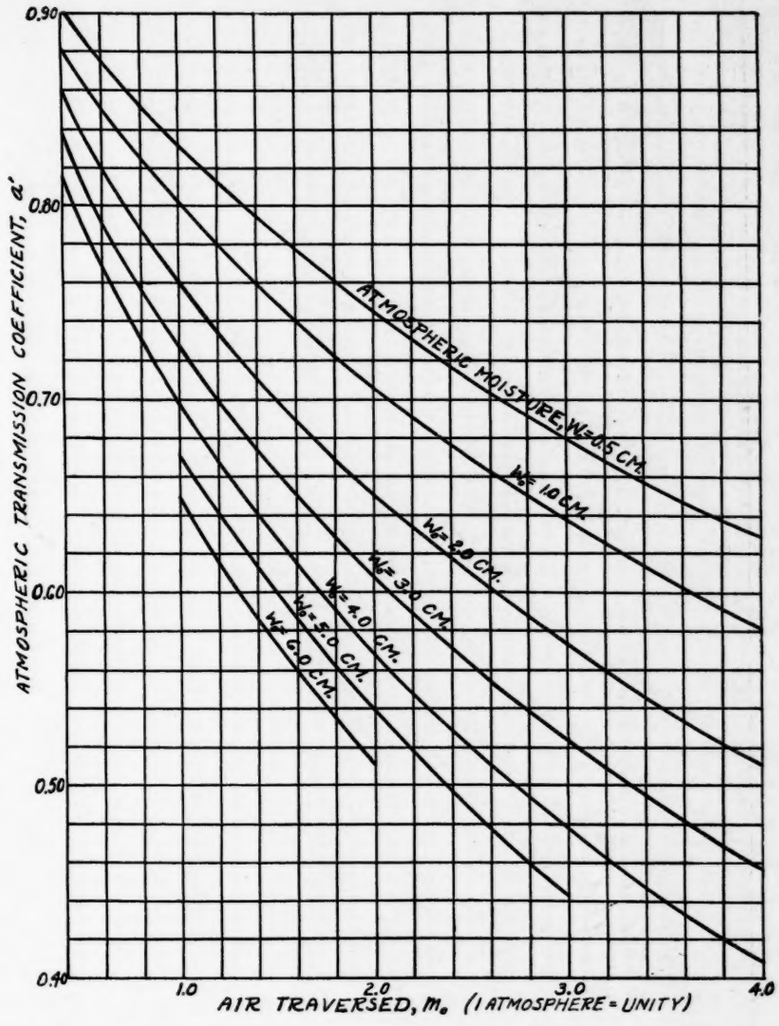


Fig. 1. Solar radiation transmission coefficient for dust-free moist air computed for atmospheric pressure of 29.92 in. of mercury.

assist in estimating the depletion of solar radiation intensity by dust. While it is recommended that direct measurements be made in all cases, the foregoing method should give the intensity within about 5% if the dust depletion is carefully estimated.

Partial Shading of Glass Areas

Partial shading of the glass areas by projections of the building and adjacent obstructions has almost no end of possible complications. Every installation has special features which differ from those of any other building, and a complete treatment is impossible. General similarity in building construction, however, introduces a large class of cases which differ only in minor details, as the jambs and lintels of windows. The shading by adjacent buildings also may be readily accounted for.

Fig. 2 shows the nature of the shadows cast on window glass by the window jambs and lintels, and by adjacent buildings, and indicates the dimensions necessary for the determination of their magnitudes. In terms of the dimensions given in this diagram the area of glass not shaded by shadows No. 1 and 2 is

$$A_{1\ 2} = (b+p-qK_v'/K_v)\,(h+r-sK_v/K_h)^* \qquad (3)$$

where

$A_{1\ 2}$ = unshaded area of vertical glass, square feet, and dimensions are in feet.
K_v = cosine of the angle between the sun's rays and a line perpendicular to the plane of the glass, as tabulated in the previous article.
K_h = cosine of the angle between the sun's rays and a vertical line, as tabulated in the previous article.
K_v' = K_v value for the vertical plane perpendicular to the plane of the glass. That side of the plane on which the sun shines in casting the shadow under consideration is the exterior side of the plane.

The use of this formula requires attention to several details. For example, when either of the factors of the right hand member becomes negative, $A_{1\ 2}$ is zero for then the entire window is shaded. Also, when the ratio $K_v' \div K_v$ becomes zero, the shadow shifts from one side of the window to the other, and any difference in the values of p or q on the two sides must be taken into account at this point. The values of K_v' determine which jamb casts the shadow. When the tabulated value of K_v' is zero under the rules established for reading K_v from the tables in the previous article, the sun is shining on the face of the jamb in question and it casts no shadow. Further, if a shadow is cast it may not reach the glass and, therefore, has no effect on the effective area. In this case the quantity $p-qK_v'/K_v$ becomes positive and is neglected. Similarly, when the quantity $r-sK_v/K_h$ becomes positive it is neglected, for then shadow No. 1 does not reach the glass.

Equation (3) slightly modified can be made to account for the shadows Nos. 3 and 4 of the diagram. The shadow No. 3 is cast by the top of a wall with horizontal ridge, and shadow No. 4 is cast by the vertical line of the corner of a building. In terms of the dimensions given in the diagram, the unshaded area is,

$$A_{1\ 2\ 3\ 4} = (b+p-qK_v'/K_v+q'K_v'/K_v-p')\ (h+r-sK_v/K_h+s'K_v/K_h-r')^{**} \qquad (4)$$

where the subscripts to A indicate the shadows which are accounted for.

Again the formula must be used carefully. The same remarks apply as to Equation (3), and in addition the quantities $q'K_v'/K_v-p'$ and $s'K_v/K_h-r'$ are each neglected as they become positive.

*This formula is valid only when the edge of both the shadows shown in the sketch fall on the glass. When shadow No. 1 does not reach the glass, the quantity $r-sK_v'/K_v$ becomes positive and is neglected. If it passes completely over the glass, $h+r-sK_v/K_h$ becomes negative. Since the entire glass is shaded, $A_{1\ 2} = 0$ in this case.

**Note that this formula is valid only when the edges of all the shadows actually fall on the glass.

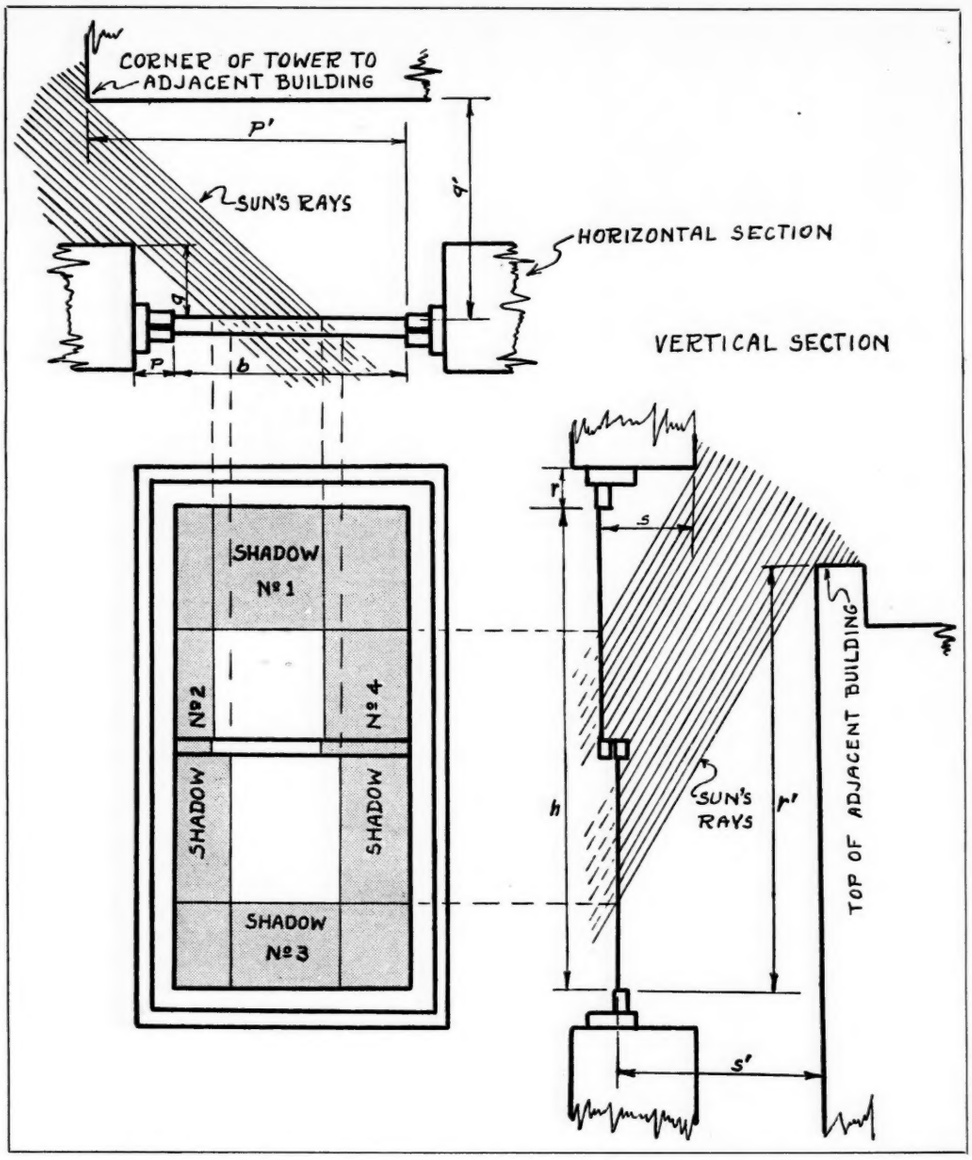


Fig. 2. Shadows on window glass and dimensions fixing their magnitudes.

The unshaded area for any possible combination of the shadows 1, 2, 3, and 4 may be obtained from this formula. The quantity $r\text{-}sK_v/K_h$ deducts the area of shadow No. 1; $p\text{-}qK_v'/K_v$ deducts the area of shadow No. 2; $s'K_v/K_h\text{-}r'$ deducts the area of shadow No. 3, and $q'K_v'/K_v\text{-}p'$ deducts the area of shadow No. 4. By including only those quantities for which the corresponding shadows exist, any desired combination is obtainable. In this way 16 different equations may be made from Equation (4). Equation (3) is one of these. It neglects shadows Nos. 3 and 4.

A convenient use of Equation (4) arises in determining the portion of a wall not shaded by an adjacent building or wall with horizontal ridge parallel to the shaded wall. Equation (4) then reduces to the following equation which gives this area directly if the shadow extends completely across the wall in question.

$$A_2 = b(h + s'K_v/K_h - r') \qquad (5)$$

Further, the quantity $s'K_v/K_h\text{-}r'$ in Equation (5) gives the height of the shadow on the wall. Similarly, the equation

$$A_4 = (b + q'K_v'/K_v - p')h \qquad (6)$$

can be made to tell if the shadow extends completely across the wall, when the dimensions to the vertical line passing through an end of the wall are substituted for p' and q'. A little experience with these equations will teach many other such uses.

The case of skylights or horizonal glass shaded by nearby walls has a solution very similar to Equation (3) for vertical glass. If the tops of the walls are assumed parallel to the edges of the glass, the following formula applies:

$$A_h = (l + p_l - q_l K_{vw}/K_h)(w + p_w - q_w K_{vl}/K_h) \qquad (7)$$

where

A_h = unshaded area of horizontal glass.
l = length of opening, or as a subscript indicates an edge along the length.
w = width of opening, or as a subscript indicates an edge across the width.
p = distances of the shading walls from the opening.
q = elevations of the tops of the shading walls above the opening.

and K_{vw} and K_{vl} are read from the tables for K_v in the previous article for the azimuth indicated by the subscript w or l. To fix the azimuths of these shading walls the side of the wall on which the sun would shine in forming any given shadow is considered as the exterior side of the wall. Again, when either of the factors becomes negative A_h is zero. Also, when either of the $K_v \div K_h$ ratios passes through zero the corresponding shadow shifts. When $K_{vw} \div K_h$ passes through zero the shadow shifts from end to end, and from side to side when $K_{vl} \div K_h$ passes through zero. The existence or non-existence of K_{vw} and K_{vl} under the foregoing definition determines whether or not the wall casts a shadow toward the glass. Further, if either of the quantities $p_l\text{-}q_l\ K_{vw}/K_h$ or $p_w\text{-}q_w\ K_{vl}/K_h$ is positive,

the corresponding shadow does not reach the glass, and the whole item is neglected.

These equations for partial shading include the more important cases. Other special conditions that arise must be treated individually.

Reflection and Absorption by Glass

Radiation intensity and transmitting area are not alone sufficient for a determination of the energy actually entering a room, for not all of the radiant energy striking an area of glass is transmitted through it. Reflection occurs on both surfaces of the glass and part of the energy is absorbed. The reflected heat depends on the incidence angle and can, therefore, be tabulated against the value of K_v or K_h. The following table shows the transmission, T, through ordinary clear glass.

TRANSMISSION OF RADIANT ENERGY THROUGH CLEAR GLASS

K	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
T	0	0.240	0.480	0.650	0.750	0.820	0.875	0.902	0.912	0.916	0.918
KT	0	0.024	0.096	0.195	0.30	0.41	0.52	0.63	0.73	0.82	0.918

For clear glass the effect of internal absorption is small and is not included in this table. Of far greater importance is the absorption caused by the accumulation of dirt and foreign matter on the surfaces of the glass. This item must be found by experiment. With the values of T given, an approximate determination of the total sun effect through clear glass is possible by the following relation,

$$H = (A_n K_v T + A_h K_h T + 0.05\, A_v + 0.10 A_{ho}) I_o \qquad (8)$$

where

H = B.t.u. per hour entering the room by sun effect.
A_n = effective vertical glass area for direct radiation as determined by Equation (4), square feet.
A_h = effective horizontal glass area from Equation (7), square feet.
A_v = total vertical glass area, square feet.
A_{ho} = total horizontal glass area, square feet.

The quantity $(0.05\ A_v + 0.10\ A_{ho})I_o$ accounts for diffuse radiation from a clear illuminated sky.

Computations

The following example and its solution is submitted to illustrate the use of the foregoing information.

Determine the amount of radiant energy passing through a window with azimuth of 30° at 10 a.m. mean solar time, August 25, for a location at 45° north latitude.

Data

Average wet bulb temperature, 70.4°
Barometric pressure, 28.5 in. of mercury
Elevation above sea level, e, 600 ft.
and window dimensions as follows:

b = 3 ft.
h = 6 ft.
p = 0.5 ft.
q = 1.5 ft.
r = 0.2 ft.
s = 1.5 ft.

From the Keenan steam tables the vapor pressure corresponding to 70.4° wet bulb temperature is 0.75 in. of mercury. This value and 600-ft. elevation substituted in Equation (1) give

w = 4.30 centimeters of atmospheric water

Also from Table 2 and Table 5 section 2 in the previous article,

$K_v = 0.667$
$K_v' = 0.170$
$K_h = 0.726$

then, since $\text{Csc}\ \theta = 1 \div K_h$

$$m = 1.377$$

by Equation (2). The corresponding values of w_o and m_o for determining the atmospheric transmission coefficient, a′, from the diagram are

$$m_o = \frac{28.5}{29.92} \times 1.377$$

= 1.278 atmospheres traversed for the same absorption with B = 29.92 in. of mercury.
and

$$w_o = \frac{29.92}{28.5} \times 4.30$$

= 4.52 centimeters of atmospheric water.

These values in the accompanying diagram give

$$a' = 0.643$$

If the depletion by dust particles is estimated at 10% the total atmospheric transmission is

$$a = 0.543$$

and the radiation intensity becomes (See previous article for Equation),

$I_o = 429a$
$= 0.543 \times 429$
$= 233$ B.t.u. per hr. per sq. ft.

From Equation 3 the unshaded transmitting area is

$A_{1\ 2} = 3(6 + 0.2 - 1.5 \times 0.667 \div 0.726)$
$= 3 \times 4.823$
$= 14.5$ sq. ft.

Note that the quantity

$$p - qK_v' \div K_v = 0.5 - 1.5 \times 0.170 \div 0.667 = 0.115$$

is positive and is therefore neglected in determining $A_{1\ 2}$. Thus, only shadow No. 1 reaches the glass.

The total area is

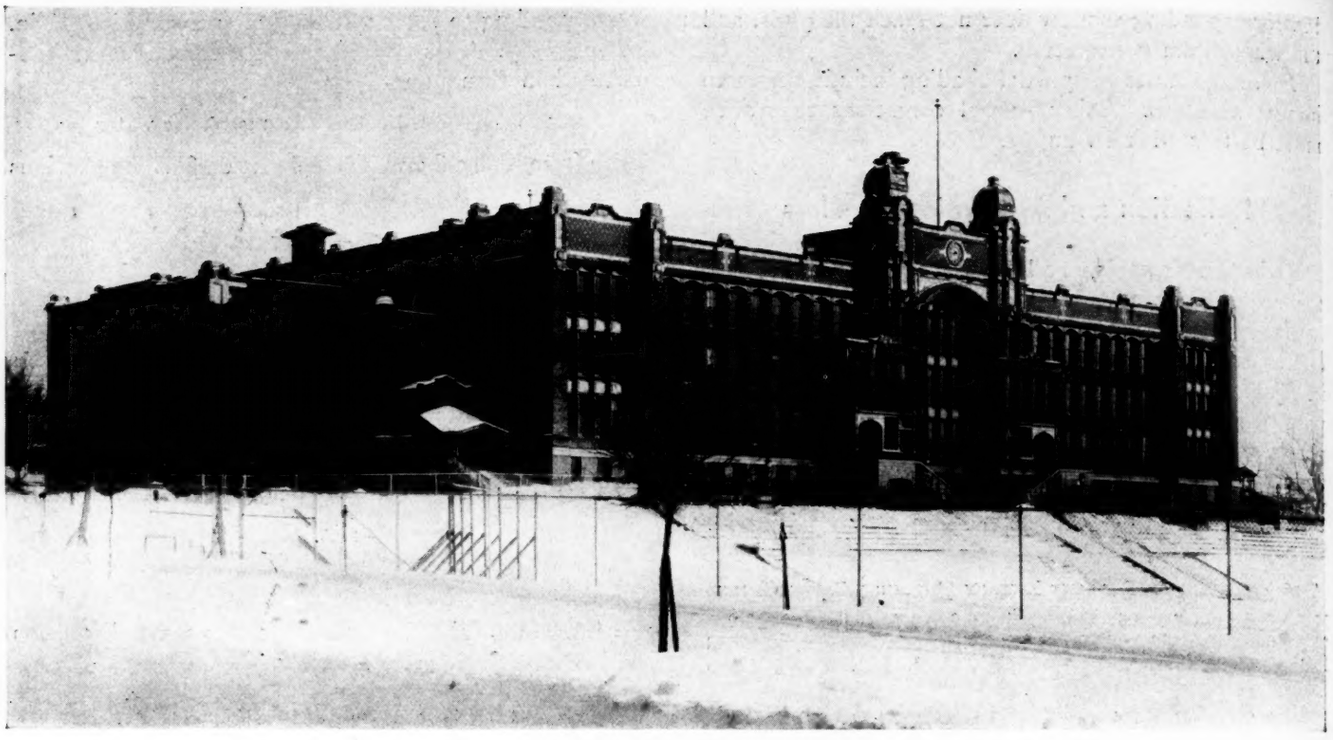
$A_v = 3 \times 6$
$= 18$ sq. ft.

From the table giving the transmission through glass

$$T = 0.908 \text{ for } K_v = 0.667$$

Then, from Equation (8) the rate of heat reception through the window is

$H = (14.5 \times 0.667 \times 0.908 + 0.05 \times 18) \times 233$
$= 2260$ B.t.u. per hr.



Rear view of East High School, Salt Lake City, Utah

Gas Heating Shows Savings in Salt Lake City Schools

By HOWARD BARKER†

WHICH fuel is cheaper for heating a school building—gas or coal? This question is met on every hand in a community in which the two fuels are competitive, but until definite data are obtained from long-time tests of both fuels in identical plants, no intelligent answer to this question is possible.

Since the advent of natural gas fuel into the Salt Lake City territory in 1929 there has been considerable conjecture as to the relative merits of the two fuels. However, after about four years of gas-heating service in plants formerly heated with coal and after some very intensive testing of the two fuels in one building equipped with duplicate boilers, some rather definite conclusions may be drawn which indicate the relative merits of the two fuels.

Six of the 40 school-heating plants in Salt Lake City are now fired with gas. Of these, one plant was installed new as a gas job, two others are in buildings to which additions were built between the time of coal-firing and gas-firing, and the other three plants, the Wasatch, South Junior, and East High, are in buildings which have remained the same during the entire period of testing.

†Superintendent of Buildings and Grounds, Board of Education, Salt Lake City, Utah.

Methods of Testing

Two methods of testing were used, short-time and long-time. Each short-time test consisted of one day's run, continuing with the same fuel for a school week before changing to the other fuel. Long-time tests consisted of comparing quantities and costs of fuel consumed on an annual basis before and after conversion from coal to gas, taking into consideration variations in outside temperatures and volumes of heated space.

Short-Time Tests

All short-time tests were conducted at the East High School, a building having a volume of 2,215,000 cu. ft. of heated space and equipped with duplicate 200 hp. horizontal return tubular boilers. One boiler is equipped with a Westinghouse-Roney overfeed, natural draft stoker, and the other with Sonner Perfecto gas burners and automatic pressure and damper controls. Since either boiler has sufficient capacity to carry the

peak load of the entire building in the coldest weather, the two fuels were alternated from week to week until sufficient information was obtained under various weather and load conditions conclusively to indicate relative efficiencies for this particular plant.

For each day's run the following data were carefully recorded: duration of test, steam pressure, feed water temperature, weight of water evaporated, quality of steam, and amount of fuel consumed. During a coal test, in addition to weighing the coal, each batch was sampled and an analysis made for each day's composite sample. The ashes were also weighed and at intervals analyzed. During all tests the flue gases were analyzed at frequent intervals, especially for CO_2. These values varied considerably for different firing conditions, but in most cases were consistent enough to be recorded as averages for each day.

After each day's run the following calculations were made: factor of evaporation, total equivalent evaporation and equivalent evaporation per hour from and at 212°, boiler horsepower developed, per cent rating of boiler, actual and equivalent evaporation per cubic feet of gas or per pound of coal, and per cent heat absorbed by the steam (efficiency).

A consistent relationship was found between water evaporated and fuel burned, as shown in Fig. 1, each point indicating a day's run. From this information the average quantities of gas equivalent to one ton of coal were readily found for various loads. These latter values, together with a typical load curve for a school year, are shown in Fig. 2.

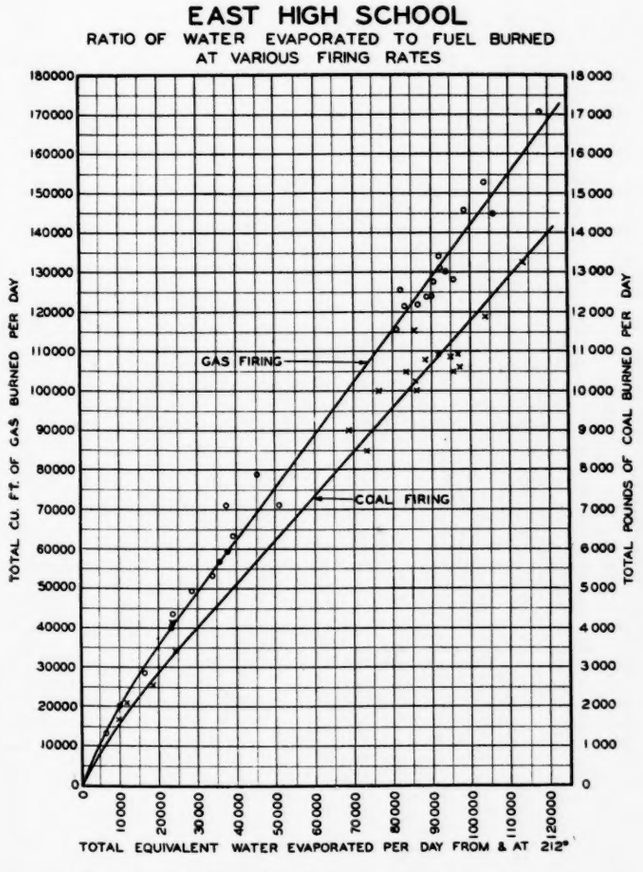

EAST HIGH SCHOOL
RATIO OF WATER EVAPORATED TO FUEL BURNED AT VARIOUS FIRING RATES
TOTAL CU. FT. OF GAS BURNED PER DAY
TOTAL POUNDS OF COAL BURNED PER DAY
GAS FIRING
COAL FIRING
TOTAL EQUIVALENT WATER EVAPORATED PER DAY FROM & AT 212°

Fig. 1. Relationship between fuel burned and Evaporation of water

Note the sag in the "Gas : Coal Equivalent" curve during the months of December, January, and February, indicating, as the tests showed, that the coal-fired boiler had its best relative efficiency when evaporating from about 30,000 lb. to 80,000 lb. of water per day. Expressed in another way, the coal-fired boiler had its best range of efficiency when operated between 65% and 115% rating. Above and below these limits it lost efficiency faster than did the gas-fired boiler.

Again referring to Fig. 2, note that, according to the data obtained from short-time tests, the gas equivalent to one ton of coal varied from 21,310 cu. ft. to 24,400 cu. ft. As will be explained later in more detail, however, long-time tests at this same school have conclusively proven that this relationship is not accurate when considered on an annual basis. As shown by the broken line the average gas:coal equivalent over a period of about two years at this same school was 17,200 cu. ft. to one ton.

Long-Time Tests

In order to obtain a standard method by which fuel consumptions and costs for the same or different buildings might be compared from year to year, regardless of the particular fuel used, two arbitrary measures—the *School Degree-Day* and the *Load Unit*—have been adopted.

The school degree-day is a measure of outside weather conditions on school days only. Its value, therefore, is found by deducting the degree-days for Saturdays, Sundays, and holidays from the total degree-days for the period under consideration.

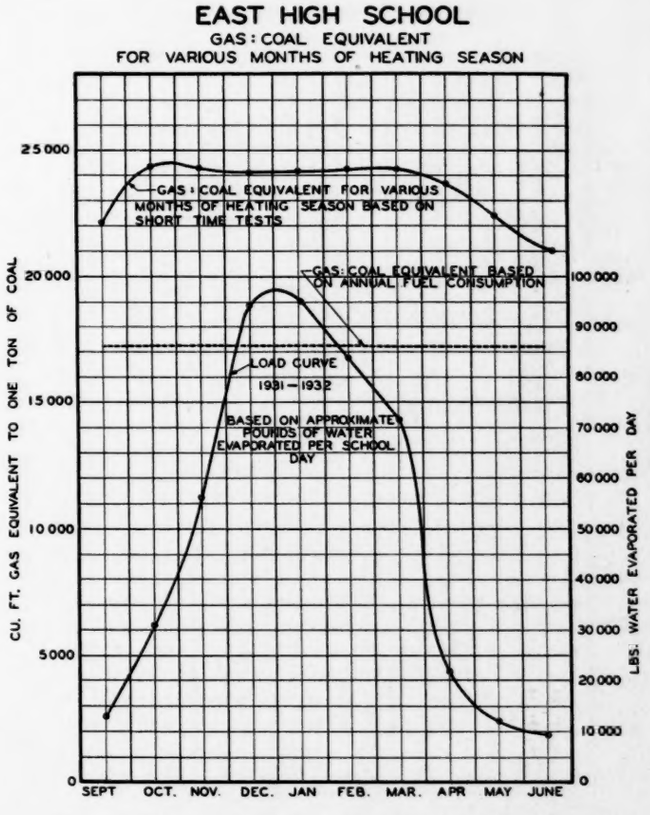

EAST HIGH SCHOOL
GAS : COAL EQUIVALENT FOR VARIOUS MONTHS OF HEATING SEASON
GAS : COAL EQUIVALENT FOR VARIOUS MONTHS OF HEATING SEASON BASED ON SHORT TIME TESTS
GAS: COAL EQUIVALENT BASED ON ANNUAL FUEL CONSUMPTION
LOAD CURVE 1931—1932
BASED ON APPROXIMATE POUNDS OF WATER EVAPORATED PER SCHOOL DAY
CU. FT. GAS EQUIVALENT TO ONE TON OF COAL
LBS. WATER EVAPORATED PER DAY
SEPT OCT. NOV. DEC. JAN FEB. MAR. APR MAY JUNE

Fig. 2. Gas : coal equivalent, and typical load curve for school year

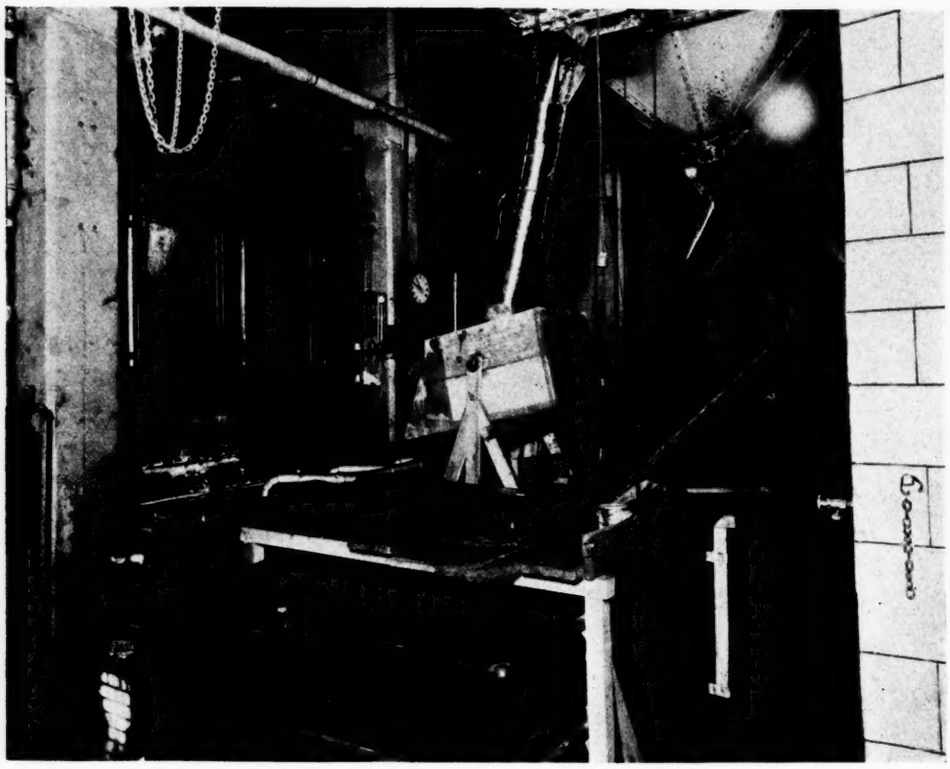


Fig. 3. Coal-weighing equipment for one of the coal-fired boilers in the East High School used during the tests.

The load unit used in this discussion has been arbitrarily assumed as the heating load represented by 1,000,000 cu. ft. of heated space for one degree-day of outside temperature.

The load units per year for any school building would then be found by the simple formula:

$$\text{Load Units} = \frac{\text{Cubic Feet of Heated Space} \times \text{School Degree-Days}}{1{,}000{,}000}$$

Tables 1 and 2 show annual heating loads, consumption of fuel, and fuel costs for a number of schools using both coal and gas during the past few years. As before stated, however, only three of these schools, the Wasatch, South Junior, and East High, remained constant as to size of building, heating equipment, etc., during the entire period under consideration. Table 3, which summarizes the comparative data based on long-time tests, therefore includes data on these three only.

It should be noted that the gas data shown in Table 3 are for the years 1931-32 and 1932-33 (to March 31) since before that time there were several changes in gas rates (fortunately downward in all cases). The present schedule of gas rates which applies to all three buildings included in the comparison is as follows:

First ..... **100,000 cu. ft. per mo. 25c per 1000 cu. ft.**
Next ..... **400,000 cu. ft. per mo. 20c per 1000 cu. ft.**
Next ..... **500,000 cu. ft. per mo. 19c per 1000 cu. ft.**
All Over .....**1,000,000 cu. ft. per mo. 18c per 1000 cu. ft.**
Minimum bill $250 per year.

One of the most interesting results disclosed by the long-time tests is the fact that the cubic feet of gas equivalent to one ton of coal is practically constant even though there is a wide variation in the sizes of buildings. The fact that stoker equipment was used for coal-firing at the East High School, whereas the other two plants were hand-fired, seems to have had less effect on the gas to coal ratio than might have been expected.

The wide variation between the average gas to coal equivalent indicated by the short-time tests at the East High School (about 24,000 cu. ft. of gas to one ton of coal) and the average indicated by the long-time tests at the Wasatch, South Junior, and East High (16,867 cu. ft. of gas to one ton of coal) calls for some explanation. Invariably, we are told that in converting from 12,500 B.t.u. coal to 850 B.t.u. gas, a total gas consumption of about 25,000 cu. ft. can be expected for each ton of coal previously burned. This comparison may be approximately correct for heating plants which are on practically continuous operation throughout the year, but it is far from right for school heating. The large percentage of mild-weather heating during the school year, together with the intermittent nature of both the daily and weekly demands—neither of which conditions would exist in the ordinary power plant—help to make gas relatively more efficient than coal for school heating.

During periods of light loads the coal-fired plant often has several hundred pounds of partly-burned coal on the grates when it is time to shut down. It is quite possible that less coal could not have been used and the required steam pressure obtained. In the case of the gas-fired boiler under exactly the same load conditions, the gas could have been fired at any desired rate for a short time and then turned off the instant the proper steam pressure or heat storage had taken place. The relative advantage of gas over coal under these conditions is apparent.

Another interesting fact disclosed by the long-time tests is the very close comparison between the cost of gas and coal per load unit at all three schools. At the East High School the costs happen to be exactly equal,

TABLE 1

COAL COSTS FOR SALT LAKE CITY SCHOOLS WHICH WERE LATER CONVERTED TO GAS-FIRING

School	Cu. Ft. Heated Space	School Year	School Degree-Days	Load Units	Coal Used: Total Tons	Coal Used: Lb. Per Load Unit	Cost of Coal: Total	Cost of Coal: Per Ton	Cost of Coal: Per Load Unit
Irving Jr.	524,600	1927-28	3,353	1,759	185.55	210.97	$724.38	$3.90	$.412
		1928-29	3,934	2,064	177.65	172.14	784.57	4.42	.380
		Average				190.01		4.12	.394
Jackson Jr.	554,400	1927-28	3,353	1,859	229.40	246.81	829.80	3.62	.446
		1928-29	3,934	2,181	292.20	267.95	1,011.82	3.46	.464
		1929-30	1,213	672	96.60	287.29	338.11	3.50	.503
		Average				262.37		3.52	.463
South Jr.	810,700	1927-28	3,353	2,718	274.20	201.75	978.35	3.57	.360
		1928-29	3,934	3,189	307.31	192.71	1,021.70	3.33	.320
		1929-30	1,213	983	106.30	215.89	373.54	3.51	.380
		Average				199.65		3.45	.344
Wasatch	472,700	1927-28	3,353	1,585	178.55	225.30	633.97	3.55	.400
		1928-29	3,934	1,860	177.05	190.42	618.65	3.49	.333
		1929-30	1,213	573	61.45	214.34	263.03	4.28	.459
		Average				207.59		3.63	.377
East High	2,215,000	1927-28	3,353	7,427	741.49	199.67	2,107.09	2.84	.284
		1928-29	3,934	8,714	844.14	193.75	2,762.33	3.27	.317
		1929-30	3,458	7,659	743.70	194.20	2,627.15	3.53	.345
		1930-31	4,003	8,867	753.15	169.88	2,634.68	3.50	.297
		Average				188.72		3.28	.310

Above schools were converted to gas-firing on following dates: Irving Jr. in September, 1929, Jackson Jr., South Jr., and Wasatch in January, 1930, and East High School in September, 1931.

showing that at that school, coal at 3.28 per ton is exactly equal to gas at an average of 19.1 cents per 1000 cu. ft.

Possible Savings in Labor, Maintenance, etc.

The following total annual heating costs at the East High School show the savings effected in labor, maintenance, etc., by converting from coal to gas. The coal figures are average values for the four years from 1927-28 to 1930-31, inclusive. The gas figures are for the year 1931-32.

ANNUAL HEATING COSTS—COAL

Coal: 770.62 tons @ $3.28	$2,532.81
Maintenance of boilers and stokers	690.97
Maintenance of ash hoist (estimate)	18.00
Power for stokers and ash hoist: 2437 kw. @ 2.96c	72.14
Ash removal: 93.67 tons @ $1.37	128.33
Fireman: 8 months @ $110.00 per mo.	880.00
	$4,322.25

TABLE 2

GAS FUEL COSTS FOR SALT LAKE CITY SCHOOLS

School	Cu. Ft. Heated Space	School Year	School Degree-Days	Load Units	1000 Cu. Ft. Gas Used: Total	1000 Cu. Ft. Gas Used: Per Load Unit	Cost of Gas: Total	Cost of Gas: Per 1000 Cu. Ft.	Cost of Gas: Per Load Unit
Irving Jr.	1,119,000	1929-30	3,458	3,870	5.915	1 528	$1,595.66	$0.270	$0.412
		1930-31	4,003	4,479	6.148	1.373	1,406.00	0.229	0.314
		(1931-32	3,990	4,465	6,327	1.417	1,279.59	0.202	0.287
		(1932-33	3,637	4,070	4,761	1.170	958.96	0.201	0.236
		*Average				1.300		0.202	0.262
Jackson Jr.	959,100	1929-30	2,245	2,153	4.134	1.920	1.077.90	0 261	0.501
		1930-31	4,003	3,839	6,037	1.572	1,381.37	0.229	0.360
		(1931-32	3,990	3.827	5,732	1.498	1,171.21	0.204	0.306
		(1932-33	3,637	3,488	4,971	1.425	1,005.48	0.202	0.288
		*Average				1.463		0.203	0.298
South Jr.	810,700	1929-30	2,245	1,820	4.107	2.257	1,073.25	0.261	0.590
		1930-31	4,003	3,245	6,698	2.064	1,517.66	0.227	0.468
		(1931-32	3,990	3,235	6,124	1.893	1,241.44	0.203	0.384
		(1932-33	3,637	2,949	4,134	1.402	843.82	0.204	0.286
		*Average				1.658		0.203	0.337
Wasatch	472,700	1929-30	2,245	1,061	2,700	2.544	757.10	0.280	0.714
		1930-31	4,003	1,892	3,685	1.947	886.52	0.241	0.469
		(1931-32	3,990	1,886	3,539	1.876	745.90	0.211	0.395
		(1932-33	3,637	1,719	2,745	1.597	575.78	0.210	0.335
		*Average				1.743		0.210	0.367
East High	2,215,000	(1931-32	3,990	8,838	15,192	1.719	2,910.04	0.192	0.329
		(1932-33	3,637	8,056	12,237	1.519	2,330.02	0.190	0.289
		*Average				1.623		0.191	0.310
South High and Whittier	2,884,800	(1931-32	3,990	11,510	20,044	1.741	3,195.77	0.159	0.278
		(1932-33	3,637	10,492	14,455	1.378	2,287.75	0.158	0.218
		*Average				1.567		0.159	0.249

Values for 1932-33 are from September 1, 1932 to March 31, 1933, inclusive.

*Average for years 1931-32 and 1932-33, during which time gas rate remained constant.

TABLE 3.

COMPARATIVE DATA: GAS VS. COAL BASED ON LONG-TIME TESTS

School	COAL Lb. Per Load Unit	COAL Load Units Per Ton	COAL Average Cost Per Ton	COAL Average Cost Per Load Unit	GAS Cu. Ft. Per Load Unit	GAS Cu. Ft. = to 1 Ton of Coal	GAS Average Cost per 1000 Cu. Ft.	GAS Average Cost per Load Unit	Cost of Gas Equal to 1 Ton of Coal
Wasatch-Elementary	207.59	9.634	$3.63	$0.377	1743	16,792	$0.210	$0.367	$3.53
South Junior High..	199.65	10.017	3.45	0.344	1658	16,609	0.203	0.337	3.37
East High	188.72	10.598	3.28	0.310	1623	17,200	0.191	0.310	3.28
					Average	16,867			

Typical Coal Analysis

Fixed Carbon	49.51%
Volatile Matter	38.33
Sulphur	.68
Moisture	4.36
Ash	9.89
B.t.u. per Lb., Dry	12,434

Typical Gas Analysis

Methane	86.2%
Ethane	7.1
Carbon Dioxide	0.1
Nitrogen	6.5
Oxygen	0.1
B.t.u. per Cu. Ft.	848

@ 12.6 lb. absolute pressure plus 4 oz. gauge.

ANNUAL HEATING COSTS—GAS

Gas: 15,192,000 cu. ft.	$2,910.04
Maintenance of boiler: no cost first year, estimate for future years	50.00
Fireman: eliminated	
Engineer: replaced with more experienced man, additional salary	180.00
	$3,140.04

ANNUAL SAVING OF GAS-FIRING VS. COAL-FIRING

Coal-firing	$4,322.25
Gas-firing	3,140.04
Annual saving	$1,182.21

It should be carefully noted that the above figures apply specifically to the East High School, and, therefore, may or may not be applicable, even in a general way, to other school-heating jobs.

It is evident from the above figures that a large saving was effected in the maintenance of the boilers by converting from coal to gas. This saving is due largely to the difference in furnace temperatures obtained with the two fuels. The maximum temperatures observed during the tests were about 2800° with coal and about 1800° with gas. The excessive expansion and contraction, spauling, and clinkering of the furnace lining when firing with coal have practically disappeared since using gas.

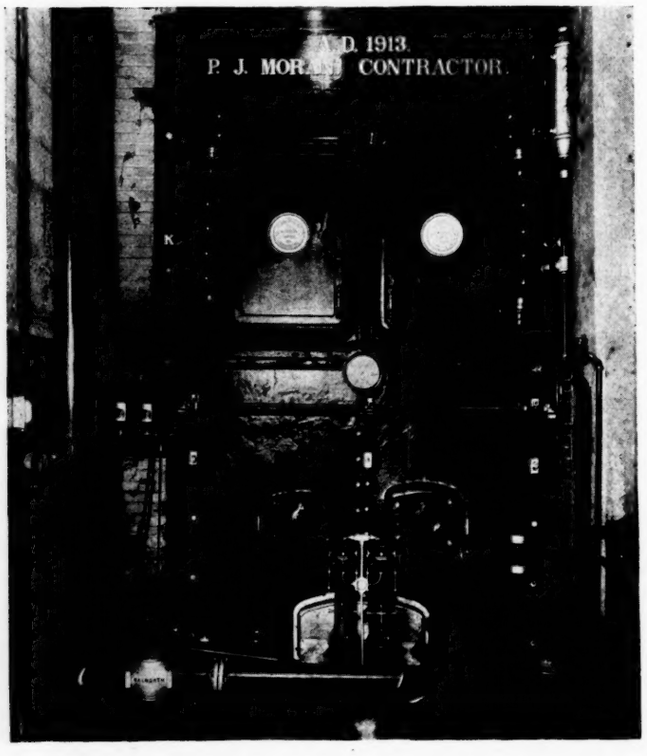


Fig. 4. A gas-fired boiler in the East High School

Conclusions

1. Short-time tests of gas vs. coal in any particular school plant may produce information which is invaluable from the standpoint of operation, but may be entirely misleading when applied to annual costs.

2. Undoubtedly, the best way to test the relative values of any two fuels is to do so on an annual basis using the bank statement as the principal testing apparatus.

3. Savings in labor, maintenance, etc., may more than offset increased cost of net fuel in making gas heating cheaper than coal.

4. Savings in labor, maintenance, ash removal, etc., for hand-fired plants converted to gas amounted to between 15% and 20% of the cost of the coal previously used. Approximately equal savings could have been effected in the same plants by installation of stokers. The principal factor governing the choice of fuel in such cases was the first cost of stoker or gas equipment.

5. Drop in furnace temperatures accounted for large savings in maintaining brick-set boilers when converted from coal to gas-firing.

6. Approximately 17,000 cu. ft. of 850 B.t.u. gas are equivalent to one ton of 12,500 B.t.u. coal for school heating, figured on an annual basis.

7. With existing gas, coal, and equipment prices there are probably no other school-heating plants in Salt Lake City which could be economically changed to gas-firing.

8. Such factors as speed, flexibility and cleanliness, though not measurable in terms of dollars, are very much noticed and appreciated when firing with gas.

9. The necessity of efficient and automatic gas-firing and damper equipment and of an intelligent and alert operating engineer cannot be over-emphasized. Even partial neglect of these factors may offset all the advantages otherwise available.

New Developments Extend Use of Arc Welding

By E. W. P. SMITH†

Electric welding has been coming along rapidly the last few years. Recent developments give this method advantages which will lead to its further adoption for pipe fabrication. The author describes the relatively new shielded-arc process, its economies and some recent examples of its use.

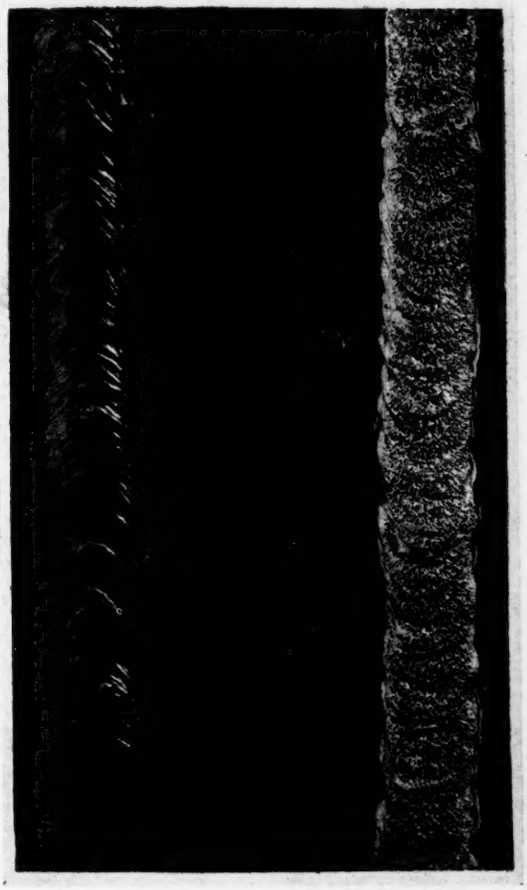


Fig. 1. Test specimen showing effects of corrosion on weld metal produced by an unshielded arc (right) and shielded-arc weld metal (left)

PROGRESS in arc welding during the last two years far exceeded that of the preceding five- or six-year period. Advancements in technique, in welding machines, and in electrodes, have served to improve markedly weld characteristics; have increased welding speeds; have cut welding costs to a fraction of their former figure, and have made possible the welding of many metals and alloys not previously considered as weldable.

Probably the most outstanding development in welding history was the introduction of the shielded-arc process. It is only within the last two years that it has been used extensively. The latest announced improvements in the process are barely months old.

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The Shielded-Arc Process

It is common knowledge with those familiar with arc welding that the molten weld metal as it is being deposited has an affinity for oxygen and nitrogen. Since the arc stream is maintained in an atmosphere composed chiefly of these elements, oxidation proceeds at a high rate during the passage of the weld metal from electrode to work. In this way oxides and nitrides are formed in the weld metal. It is the presence of the oxides and nitrides in the weld which impairs its strength, ductility, and resistance to corrosion.

If the molten weld metal is protected from contact with atmospheric oxygen and nitrogen during the process of deposition, the weld so produced will be free of oxides and nitrides. Thus, an arc, *completely shielded*

from oxygen and nitrogen, deposits weld metal superior to that deposited by an ordinary arc. The extent of this superiority can best be judged by comparisons of the structures of weld metals and physical and chemical tests.

Since the strength and ductility of welds are dependent on the purity of the weld metal and the nature of metallic structure, it is obvious that welds produced by an unshielded arc cannot possess the physical characteristics of welds made in a shielded arc. Hundreds of tests have proved that welds under stress fail at that point where the oxide and nitride content is greatest. The degree of brittleness of a weld is also largely due to the amount of oxides and nitrides contained in the weld metal.

Properties of Shielded-Arc Welds

Welds produced in a shielded arc show a tensile strength of 65,000 lb. to 75,000 lb. per sq. in.—10,000 lb. to 20,000 lb. per sq. in. greater than rolled steel.

In most applications of arc welding high ductility of the welds is as essential as high-tensile strength. A weld of good tensile strength may not be ductile. However, welds produced in a shielded arc possess both characteristics to a high degree. The results of tests demonstrate not only the high-tensile strength but also the ductility of the weld metal. In a typical test the holes drilled through the weld metal before testing were 0.182 in. in diameter. After the bar was pulled to failure it was found that this dimension of the holes was increased to 0.266 in., or an elongation of approximately 40%.

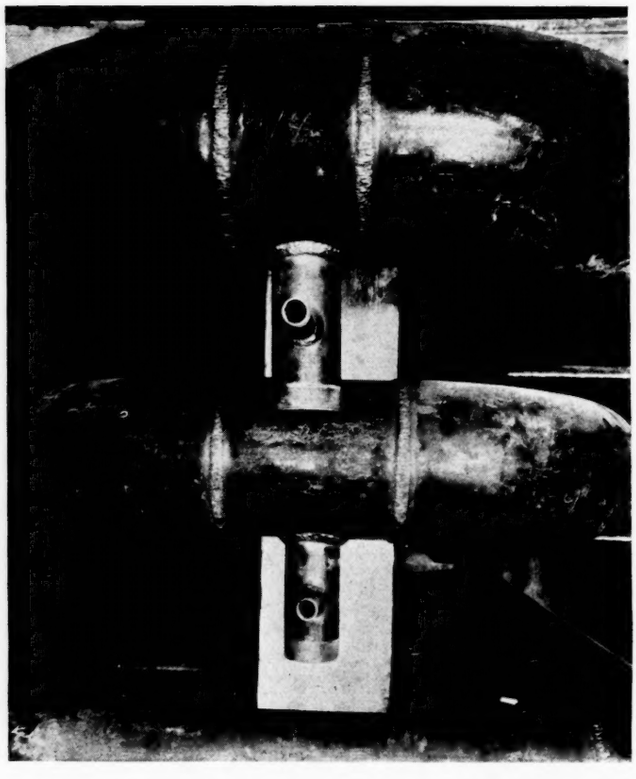


Fig. 2. Portion of the 47,000 ft. of high-pressure steam lines welded at Pilgrim State Hospital, Long Island.

Results of tests for elongation of weld metal deposited in a shielded arc are given below. The specimens tested consisted of coupons cut from pure weld metal. Note the great ductility of shielded-arc weld metal.

ELONGATION IN 2 IN.

Weld Metal	Min.	Max.	Aver.
Shielded Arc	18%	27%	23%
Ordinary Arc	8%	12%	10%

Corrosion

The effects of corrosion on the weld metal and the parent metal are an important factor which should be given serious consideration in the determination of the method or process of arc welding to employ. This is especially true of the welding of piping which would be subjected to acid fumes, weather conditions, or burying in the ground.

The effects of corrosion on welds made with shielded and unshielded arcs can be easily ascertained after a 72-hr. immersion of the welds in a 50% solution of hydro-chloric acid. The welds (Fig. 1) were subjected to this particular corrosion test. Close inspection of this illustration reveals that though the weld produced by the shielded arc is not affected, the acid has eaten rather deeply into the weld metal deposited by the unshielded arc. The corrosion of this weld is due to the presence of foreign material, mostly iron oxide, in the weld metal. The other weld, having been made with a shielded arc which prevented inclusion of oxides and nitrides in the weld metal, was thus able to resist corrosion to a far greater degree.

Coated Electrodes

In manual welding a shielded arc is obtained through use of specific types of electrodes which are heavily coated. The coating is of such composition that in the heat of the arc it gives off quantities of a gas which envelops and completely shields the arc from the atmosphere.

The metal core of this electrode melts faster in the arc than the coating is consumed. Thus, the projected coating forms in effect a crucible in which the electrode metal is melted. This crucible or projected coating shields the arc stream from the surrounding atmosphere for almost its entire length. However, as the edge of the projected coating is consumed in the arc, quantities of an inert gas are given off. Some of this gas combines with the oxygen of the atmosphere surrounding the arc, thus leaving no oxygen or nitrogen to combine with the molten weld metal in the process of deposition.

Welding Machines for Shielded-Arc Welding

The use of the shielded-arc process greatly improved the physical properties of the welds as well as greatly increased the speed of welding. Uniform welding current is essential for the fast production of sound welds by this process. Another requisite is that the machines must have greater capacity in order to supply the higher currents demanded by the shielded-arc process. And they must provide this added capacity without sacrificing efficiency.

Fig. 3. Assembly of pipe fittings before welding

And so, within the last year or two, the progressive manufacturers have brought out welders which maintain a uniform current, eliminate the wide fluctuations of current and voltage, have a greater capacity, and higher efficiency. They are rated at 40 volts instead of the old 25-volt rating. They permit the use of a higher average current per given size of electrode, with greater speed.

With the newer arc-welding machines and coated electrodes, it is possible to produce sound welds 100% to 300% faster than with older machines and bare or washed electrodes. Naturally, the cost per weld is reduced proportionately.

Economies of Welding

The economies effected by welding piping are not all in making the welded joint, as savings are made in many other ways. For example, pipe of thinner wall section may be used, thus reducing the steel tonnage. The necessity for heavy cast fittings is eliminated. These weight savings permit the use of lighter pipe hangers. Savings are made, too, in time and material for pipe covering due to the absence of flanges. A welded piping system is easier to lay out and to estimate. In general, it may be said that welded joints are now unquestionably more economical than flanged joints and that, other things considered, they are more economical than threaded joints in sizes above 2½ in.

Welded Piping for Federal Government

Several large piping jobs recently arc welded are interesting applications of the process described in this article. The federal government last fall let a contract for 42,800 ft. of underground steam mains for servicing public buildings in Washington, D. C. High-pressure steam mains range from 18 in. down to 4 in. in diameter, while condensate, return, and drip mains will be from 10 in. to 1¼ in. Arc-welded joints are being used.

Recently, 47,000 ft. of high-pressure steam lines for the Pilgrim State Hospital at Brentwood, Long Island, were arc welded by the J. K. Welding Company (See Fig. 2). There were 3000 circumferential welds on various sizes of pipe from 2½ in. to 14 in. Ends of the pipe were V'd to a 35° angle and butt welded. All joints were subject to 375-lb. hydrostatic pressure and the inspection passed without failure or leaks. The lines operate under 250-lb. pressure.

Below are figures for the approximate time per joint and amount of electrode used on a few of the sizes of pipe welded.

Pipe Dia., In.	Approximate Time for Welding each Joint in Place, Min.	Approximate Amount of Electrode Used per Joint, Lb.
2½	4½	⅜
3½	5½	½
6	9	1
8	12	1¾
10	15	2½
14	22	3¾

A high-pressure, high-temperature, 14-in. steam line was installed at the Piedmont plant of the West Virginia Pulp and Paper Company early in 1931. It is suspended some 30 ft. above the ground level and is 920 ft. long. After almost two years of service, this shielded-arc welded line which carries 600 lb. steam pressure at 720° has given no trouble whatsoever. The line was originally tested at 1500-lb. hydrostatic pressure.

At Ann Arbor, during the installation recently of an air conditioning system for an office building, ¾-in. and 1¼-in. piping was arc welded. This line was designed to sustain a carbon dioxide pressure of 1000 lb. Welding was specified because it took up less space and reduced the cost. Test pressures exceeding 1000 lb., with the welds soaped, failed to reveal any leaks.

The examples briefly mentioned here are typical of the work that is being done in welding piping today. Aside from the economies of welding, mentioned above, it is important to remember that welded joints permit closer spacing of pipes and provide an installation pleasing to the eye. Doing away with wrench clearances permits, in many cases, erecting piping much closer to walls and partitions. Gasket troubles are eliminated. With the use of the shielded-arc process there is no possibility of joint failure. The joint is permanently tight.

Capacitor Motors for Air Conditioning Equipment

THE attributes of the capacitor motor which recommend it, particularly for long yearly hour applications, are simplicity, few parts, low starting current, high efficiency and power factor, and freedom from radio interference.

The capacitor motor in the fractional sizes is built like the split phase or induction motor. It consists of a stator equipped with start and main coil windings arranged like those of the split phase motor; a squirrel cage rotor; a condenser, and, generally, a switch working on the centrifugal force principle to open the circuit to the start coils and start condenser. There are several types suitable for specific services, as follows:

First, the motor with a single capacitor serving both starting and running conditions, and suitable for low starting torque applications, such as fans for air conditioning units and rotary oil burners. This motor has current in both starting and running coils all the time. It has no cut-out switch, so the number of parts that could cause trouble is reduced to a minimum. In the sizes usually used, the start current on the 110-volt, 60-cycle motors amounts to from 1.5 to 5 amperes and the running current less than 1 ampere.

This low current consumption is a reflection of the high performance characteristics, such as a power factor of about 82%; efficiency, about 55%; overall efficiency about 45%. The low current consumption is an important feature for a type of motor application which must run for 2500 hr., or more, per year. It can safely stand stalled with current on for more than 30 min. without damage.

The second style of capacitor motor is one which would be suitable for heavy starting torque application, such as a gun-type oil burner using a pump and requiring a starting torque too heavy for a split-phase motor with starting current within the N.E.M.A. 20 ampere limit on 110 volts. This motor is wound the same as described above, but has a capacitor for starting and one for main coil windings, and a centrifugal switch to cut out the start windings and capacitor.

Starting current for this type of motor, rated say at ¼ hp., would be about 15 amperes at 60 cycles, 110 volts, and the running current about 3 amperes. These comparatively low currents result from high power factor and efficiency, and are desirable because of the very long yearly hour duty. The centrifugal switch breaks a comparatively small current and will give hundreds of thousands of starts without trouble.

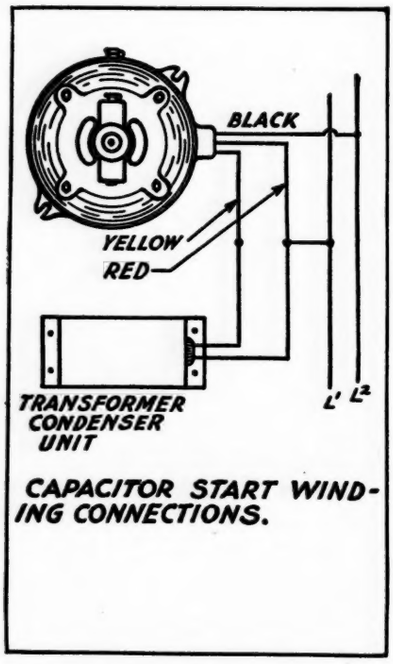
The third type of capacitor motor is that having a capacitor across the starting coils to insure heavy starting torque at low starting current. This motor uses a switch to cut out the starting coils and capacitor, and it runs as a plain squirrel cage induction motor and at corresponding efficiencies and current.

Efficiency is lower than that of the capacitor run motor and current is about 25% to 30% higher, that is, about 4 amperes for the ¼-hp. motor at 110 volts, 60 cycles. This style of motor uses the capacitor to hold down the starting current and to provide a simplified motor design with comparatively few parts and one causing no radio interference, no matter how long it is used. It is suitable for such applications as the refrigerator, where the use does not count up to so many hours per year, as is to be expected for the oil burner or air conditioner.

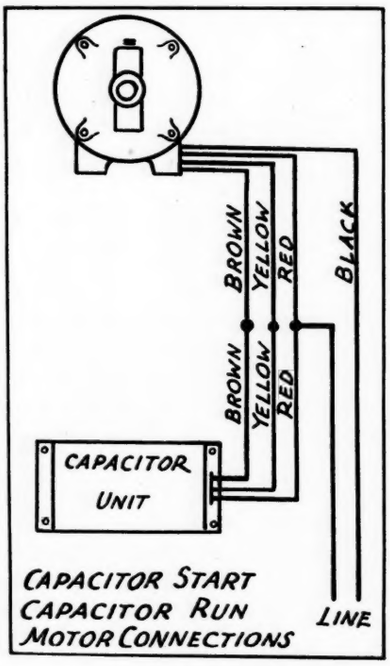
It is estimated that most of the air conditioner motors will run very long hours per year because they will be used all the year round and almost constantly, so here we should have high power factor and efficiency and low current consumption. Thus, for those cases where low starting torque is sufficient, the first type of capacitor starting and running motor without switch would be ideal. For larger installations, involving a heavy fan belt and bearings with uncertain oiling service, the second type of capacitor motor with two capacitors and a cut-out switch gives the strong start required, protection against friction and low voltage, and low running current.

For small-room size air conditioning units the less expensive shaded coil induction motor is satisfactory if well made. Although not so efficient, the torque required is so small that power consumption will not be high.

Reduced incomes have forced makers of motor-driven devices to be careful in selecting the motor most efficiently fitted to drive the appliance, as low power consumption is a strong selling point. To insure years of satisfactory service, the right type of motor must be exactly fitted to the job.—*F. W. Jessop, President, The Ohio Electric Mfg. Co., Cleveland.*



External connections for low-starting torque motor



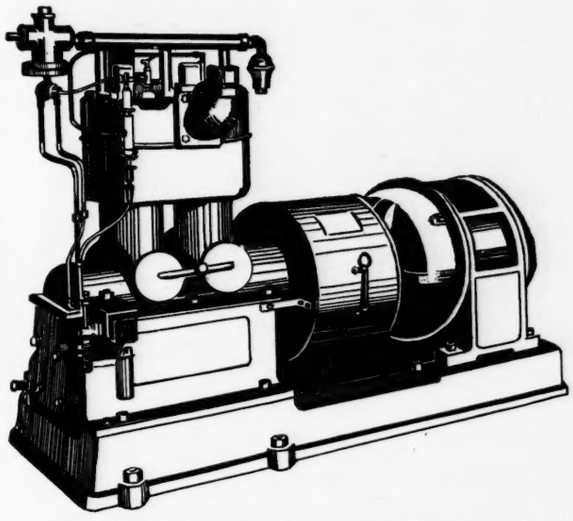
Connections for capacitor start-run motor

The Design of Compressed Air Piping for Buildings

By TELFORD R. DAVIS†

WITH the demand for use of compressed air increasing yearly the consulting engineer will frequently be asked to incorporate the air piping system in with the other mechanical systems of his projects under design.

During the past few years the writer has designed several low pressure compressed air systems for a variety of uses, some of which were unusual and listed as follows: batteries of dental pedestals for use in dental clinics; chemistry laboratories for use in connection with blow torch work, lifting dangerous acids, and other numerous uses. In addition there are other compressed air lines, such as those used for pneumatic temperature control, etc.



Direct-driven air compressor for large work

Previous to the design of these systems the writer was unable to find reliable information pertaining to the distribution of compressed air at pressures lower than 60 lb. Without exception the lower pressures were required in the installations mentioned previously. In the case of the dental clinic several pressures lower than 60 lb. were desired. For instance, in mechanical dentistry and chemistry laboratory work pressures ranging from 15 to 40 lb. were required, while dental pedestals only require a pressure of a few ounces; consequently it was necessary to devise a method that could be used in designing a system for compressed air piping and compressor size determination that would lead to intelligent and economical design.

The first approach to the problem was the development of a table of pipe sizes giving equivalent areas for pipe diameters that were as small as 1/8 in. As a basis for this table (See Table 1) the well-known Unwin-Carpenter-Babcock equation was used to determine equivalent carrying capacities. This table was used with success on some small installations but was not complete enough for complex installations where the system included risers with varying pressures, lengths, etc.

As a result a new table (See Table 2) was developed by the writer for air capacities of small pipes at various initial pressures and a loss of ½ lb. per square inch per hundred feet length. This table was developed by the use of formula using the Fritzsche Coefficients from Marks' Mechanical Engineers' Handbook. The formula is:

$$C.F.M. = 35.08 \left[\frac{(P_1^2 - P_2^2)\ (d)^5}{L}\right]^{0.54}$$

In which

P_1 = Initial Pressure
P_2 = Delivery Pressure
$P_1 - P_2$ = Pressure Drop
L = Length
35.08 = Coefficient
d = Diameter of Pipe, Inches.

A table such as Table 2 is necessary before a compressed air problem can be tackled with any degree of assurance. From such a table as this it was then an easy matter to develop a new and revised table on equivalent carrying capacities of various size pipes.

TABLE 1. RELATIVE CARRYING CAPACITIES

(Low pressure air distribution-turbulent flow. Based on Unwin-Carpenter-Babcock equation)

Diameter, In.	¼	¼	⅜	½	¾	1
¼	8	1				
⅜	26	3	1			
½	59	8	3	1		
¾	199	25	5	3	1	
1	460	58	17	8	2	1
1¼	780	110	33	14	4	2
1½	1400	190	56	24	10	4
2	2700	430	128	54	14	8

TABLE 2. C.F.M. FREE AIR DELIVERED

(Relative volumes through various size pipes, at ½ lb. pressure drop per 100 ft., for 4 initial pressures. Based on Fritzsche's coefficients)

Pipe Dia., In.	C.F.M. 15 Lb.	C.F.M. 25 Lb.	C.F.M. 40 Lb.	C.F.M. 55 Lb.
¼	.29	.396	.50	.72
⅜	.90	1.17	1.61	1.81
½	1.92	2.57	3.40	3.90
¾	5.70	7.60	9.80	11.70
1	12.50	16.50	21.40	32.00
1¼	24.60	32.40	42.00	50.00
1½	37.30	51.40	63.75	75.50
2	81.00	105.00	138.00	169.00

†Staff of C. R. Ammerman, consulting engineers, Indianapolis.

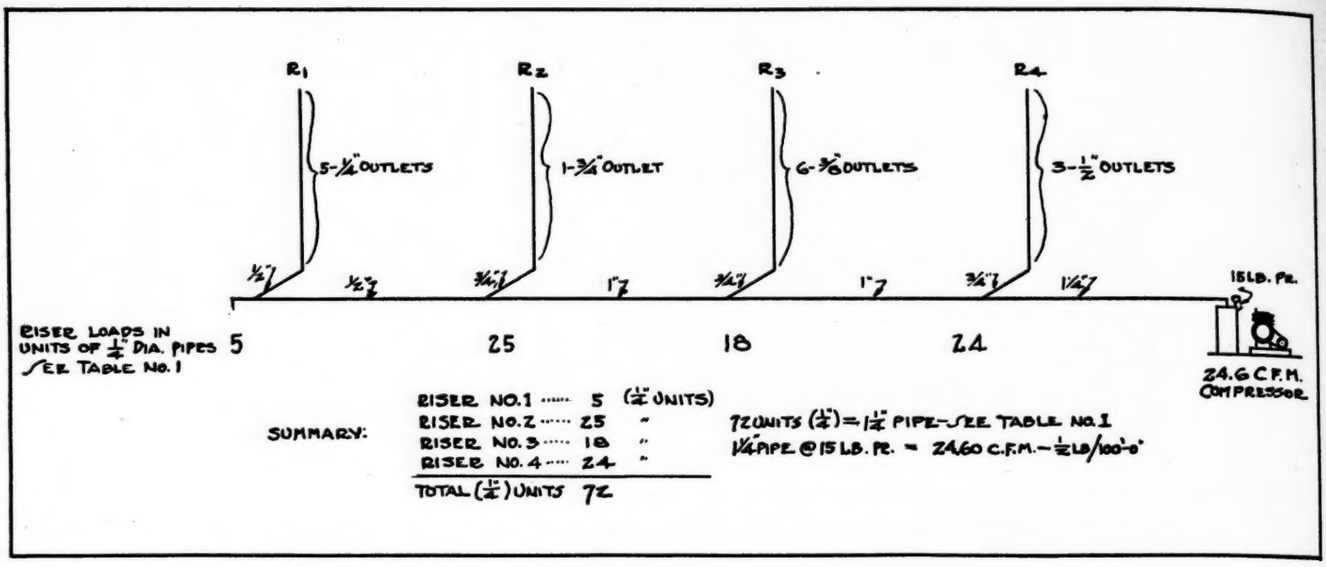


Fig. 1. Simple problem involving compressor, main, and four risers

Table 3 is the result. It is an interesting matter to compare this table with Table 1. It will be noted that Table 3 is the more conservative and a system designed by its use will be in the neighborhood of 75% of the capacity of a system designed on the equivalent carrying capacity table. On the average job, where demand factors are in question, Tables 2 and 3 could be used with safety.

Compare some working examples. Fig. 1 shows a simple problem with a compressor, main, and four branches or risers. We shall proceed to size this problem by the use of Table 1. The most convenient way is to single out the smallest outlet on the design and express the balance of the work in terms of the smallest outlet, in some such manner as has long been the practice in gas distribution. After examining the problem we find that ¼ in. is the unit we must use. We total each riser on this basis by consulting the Unwin equivalent as determined in Table 1. A summary of all risers is 72 ¼-inch units. This, from Table 1, is equivalent to a 1¼-in. pipe, which gives the size of the main after all risers or branches have been collected. Now, by the use of the formula of air flow using the Fritzsche coefficients and using a 100-ft. run basis, 15 pound initial pressure with a ½-lb. drop, the volume of free air will be 24.6 c.f.m.

TABLE 3. EQUIVALENT VOLUMES OF COMPRESSED AIR
(Through various size pipes under identical conditions)

Dia., In.	¼	⅜	½	¾	1	1¼	1½
⅜	3	1					
½	7	2	1				
¾	20	6	2	1			
1	43	14	7	2	1		
1¼	84	27	12	4	2	1	
1½	129	42	19	7	3	1.5	1
2	276	89	41	14	7	3	2

Now compare the identical problem sized entirely on the basis of actual flow conditions by the use of our other two tables. Fig. 2 shows conditions similar to Fig. 1. We proceed first by ascertaining the riser totals in terms of equivalent volumes of air delivered through ¼-in. pipes by the use of Table 3. A summary of all risers in c.f.m. gives 18.56 as the capacity of the system under the same conditions as in our first problem. Now

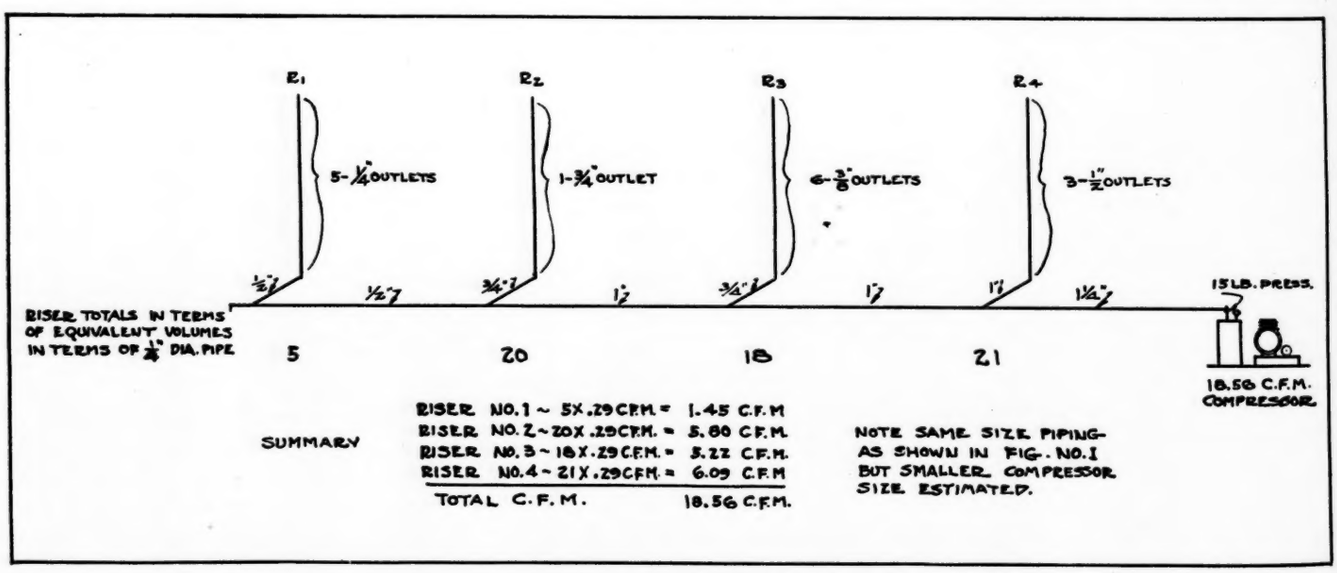
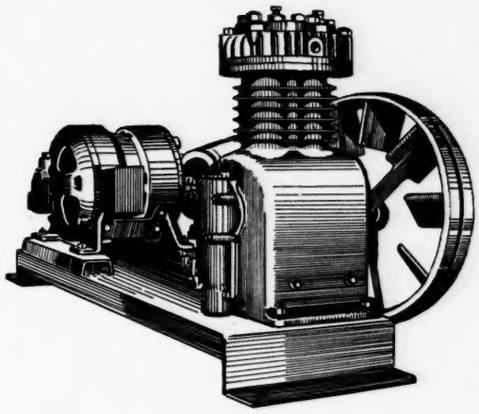


Fig. 2. Same layout as Fig. 1 calculated by different method

in our first problem the capacity was determined at 24.6 c.f.m. If no demand factors were available, it is probable that no demand factor would be applied at all. With commercial sizes of compressors usually furnished with 9, 12, 20, 31, and 41 c.f.m. piston displacement, it is seen that a 31 c.f.m. compressor would be chosen for our first problem. Now if we consider the capacity of 18.56 c.f.m. as determined by actual air delivered under our conditions by the second method, no engineer would hesitate in recommending the 20 c.f.m. machine with a considerable saving in cost to the purchaser.



Compressor and tank assembly for low-volume demands

In the solution of air storage tank problems it is necessary to convert cubic feet of free air into volumes at the pressures at which the air is stored or compressed. To do this we make use of the formula for adiabatic compression of air usually given as follows:

$$\frac{P_2}{P_1} = \left(\frac{V_1}{V_2}\right)^{1.41}$$

In which

P_1 = Absolute pressure
P_2 = Absolute pressure plus final pressure
V_1 = Free air in cubic feet
V_2 = Volume at compressed pressures.

As an example, refer again to the second problem on compressed air in which 18.56 c.f.m. was determined as the system's capacity. If the compressor was designed to compress air at 100 lb. pressure into a storage tank, what part of the volume of the tank would be occupied by the 18.56 c.f.m. at 100 lb. pressure.

Solution:

$P_1 = 14.7$ lb.

$P_2 = 14.7$ lb. $+ 100$ lb. $= 114.7$ lb.

$V_1 = 18.56$

$V_2 = (?)$

(1) $\frac{114.7}{14.7} = \left(\frac{V_1}{V_2}\right)^{1.41}$

(2) $114.7\, V_1^{1.41} = 995$

(3) $V_1 = \sqrt[1.41]{7.8}$

(4) $V_1 = 4.28$ cu. ft.

In other words, the 18.56 cu. ft. of free air occupies 4.28 cu. ft. at 100 lb. pressure. If we desire that the storage tank should hold sufficient air at 100 lb. pressure for supplying the system at 15 lb. pressure through the use of pressure reducing valves for a period of 10 minutes, we must multiply 4.28 cubic feet $\times$ 10 = 42.8 cu. ft. storage capacity. Assuming that a storage tank of 30 in. in diameter was used, this would require a tank approximately 30 in. $\times$ 65 in. long for 10 minutes' storage.

In general practice it has been found that for moderate size chemistry laboratories, compressors of from 12 to 20 c.f.m. displacement will nicely take care of the demands. For compressors used in and around boiler and power plants for general use around the plant, a displacement of from 100 to 150 c.f.m. will serve nicely. Usually the compressor will pump directly into storage tanks at 100 to 125 lb. gauge pressure. This pressure is well within the useful range in the power plant.

British Extending Heating Research Facilities

Considerable research into important heating and ventilating problems has been undertaken in the United Kingdom during the past few years, the subjects dealt with including the standardization of room conditions, effect of weather conditions upon heat requirements, a comparison between radiant and convection heating, between continuous and intermittent heating, and effects of ventilation upon heat requirements. But the desire for increased facilities for the intensive study of the heating of modern buildings has led to the decision to build an experimental room at the British Building Research Station, Watford.

Other controlled rooms have previously been in operation at the station where the regulation of the air temperature throughout the enveloping space has been attempted. However it has been found difficult, even with an elaborate system of controls, to provide clearly defined conditions in the enclosure, since there is variation in the temperatures of the enclosing walls, to which the walls of the test room radiate and from which they receive radiation.

In the new experimental room, as planned, the enclosure will be controlled by means of panel-warming and panel-cooling pipes in the walls, floor, and ceiling, and the temperature of the air in the enclosure will also be regulated. As a result, it will be possible to produce in this enclosure any defined weather conditions for a specified time and to repeat these conditions as frequently as may be necessary to obtain the statistics desired. An important increase in the knowledge of heating is expected to result from experiments undertaken in this new room. —*A. C. Blackall*

District Steam Heats First Church of Christ, Scientist, in Boston

By RAYMOND M. NEE†

A MOST extensive church property development is represented by the First Church of Christ, Scientist in Boston, Mass. The Church owns all or part of seven city blocks, the Mother Church being about the center of the property.

In 1931, the Church completed plans for the erection of one of New England's largest buildings, a publishing house and office building 600 ft. long and 75 ft. to 100 ft. wide, to house its constantly-growing organization.

For the existing publishing house, Mother Church, and other attendant buildings, electricity (115-230 volts direct current) had been purchased from the utility for years, while generating their own steam for heating, hot water, and process. The heating plant, located in the basement of the old publishing house and office building, contained six boilers, operating at 100 lb. per sq. in. gauge pressure, four of which were 28 years old and two 25 years old. This plant was just about large enough to handle the then existing load, but not capable of satisfactorily carrying the additional load to be imposed by the new building.

The Problem

The problem then was to care for this increased load. Extensive and thorough investigation of three possible solutions was made by the Christian Science organization; Chester Lindsay Churchill, its architect, who was assisted by Lockwood Greene Engineers, Inc., and The Edison Electric Illuminating Company of Boston.

These three solutions were as follows:

1. To continue purchasing electricity, and rebuild the existing boiler plant so as to add probably 10 years to its life, with the expectation (or stipulation) that utility steam service could be purchased within that time.

2. To build a power plant to supply both steam and electric requirements.

3. To purchase both electricity and steam from the utility.

†Head Engineering Division. Steam Heating Service Dept., The Edison Electric Illuminating Company of Boston.

The third solution was adopted, and a 15-year agreement was signed for steam and electric service. Electricity (alternating current) was to be furnished at 13,800 volts, while steam was to be furnished at 40 lb. per sq. in. gauge pressure. The steam service and the new electric service were to start November 1, 1932 (approximately one year after the signing of the agreement). The agreement allowed the utility the use of the old heating plant for the first year, with the understanding that on and after November 1, 1933, all steam service should be furnished from an outside source.

With the agreement signed the next problem was to lay out and install a steam main from the existing steam distribution system, the nearest point of which was 1½ miles distant.

Selection of Route

The route received the first consideration, for, of course, it should be along streets that offered the greatest present and future possibilities and yet keep the main as short as possible. Because of the probable future development of the property around the Mother Church and the possibility that some streets might be closed or relocated, the problem of a service location and steam main location through the Church property was complicated. A route was finally selected through the Church property that looked as if it might not interfere with any expansion of the Church building program. This route made available eight hotels representing a load of 55,000 lb. per. hr., as well as several large first-class office buildings and many smaller buildings of various usages.

What size should the main be? It was decided to make it large enough to supply everything adjacent to it that could be reached with a service connection and give a minimum pressure under peak load conditions at the Christian Science Building of 60 lb. (40 lb. being furnished at the meter on the low-pressure side of the company's reducing valve in the building basement. Some reducing valves require 20-lb. pressure differential for good pressure regulation, and experience has shown that most of them will operate better with such a differential.)

Consideration of Extensions

What of the future buildings, and short extensions from this feeder? These were considered, but not taken into account in sizing the steam main, for long before 100% of the adjacent business is procured additional feeders will in all probability have been installed into the same territory, with cross connections en route. Further, when the connected load threatens to exceed the capacity of these mains and feeders, a heating plant in the Back Bay district will, without a doubt, be justifiable. However, when such a plant is built the mains will still be of service in the interchange of capacity between the central heating plants.

After consideration of all of these factors, the sizes decided upon for this steam main were 12 in. and 10 in. There were required 6,389 ft. of 12 in., and 2,766 ft. of 10 in.—a total of 9,155 ft. of mains.

The problem of sizing the service, reducing valves and meter for the Christian Science Buildings was one that required a great deal of thought. With the buildings to be served totaling nearly 11,000,000 cu. ft. of gross volume, the estimates of the peak demand varied from 25,000 lb. to 35,000 lb. per hr. With the thought in mind that future building may increase the peak load to 60,000 lb. per hr., an 8-in. service was installed into the new publishing building, taken off the 10-in. street main at a tee with a 10-in. valve on either side of it so that either valve could be closed and steam supplied from the other direction. Plans for 1933 include a second steam main to the Christian Science Buildings, thus providing complete loop service.

Provisions were made for an 8-in. and a 4-in. pressure reducing valve. However, the initial installation was a 4-in. and a 2-in. pressure reducing valve with increasers to the 8-in. and 4-in. pipe, respectively.

With a possible load of 30,000 lb. per hr. in the winter, and perhaps 3,000 lb. per hr. in the summer, the size of the meter orifices was considered. It was decided to install an 8-in. adjustable orifice with a capacity that could be varied from 60,000 lb. per hr. to 1,500 lb. per hr., connected with feeder pipes to a recording and integrating meter.

A detailed study of the underground structures along the route was then made. Such detailed studies are vitally necessary for the satisfactory installation of a steam main in the streets of Boston, for the city was originally a neck of land comprising some 800 acres joined to the mainland by a narrow causeway. The marsh areas surrounding it were gradually reclaimed until now it has within its limits over 30,000 acres. the greater part of which is "made" land.

Scheduling the Construction

Much of the territory through which the steam main was to go is filled or made land. The sewers are shallow, and in times of high tide and heavy rains the sewers often fill to a point within a few feet of the street surface. There are shallow subways to cross and dodge. In this case there was also an overpass bridge over railroad tracks to cross.

Work was started in the street on May 31, 1932, and steam was turned on the last section of pipe on October

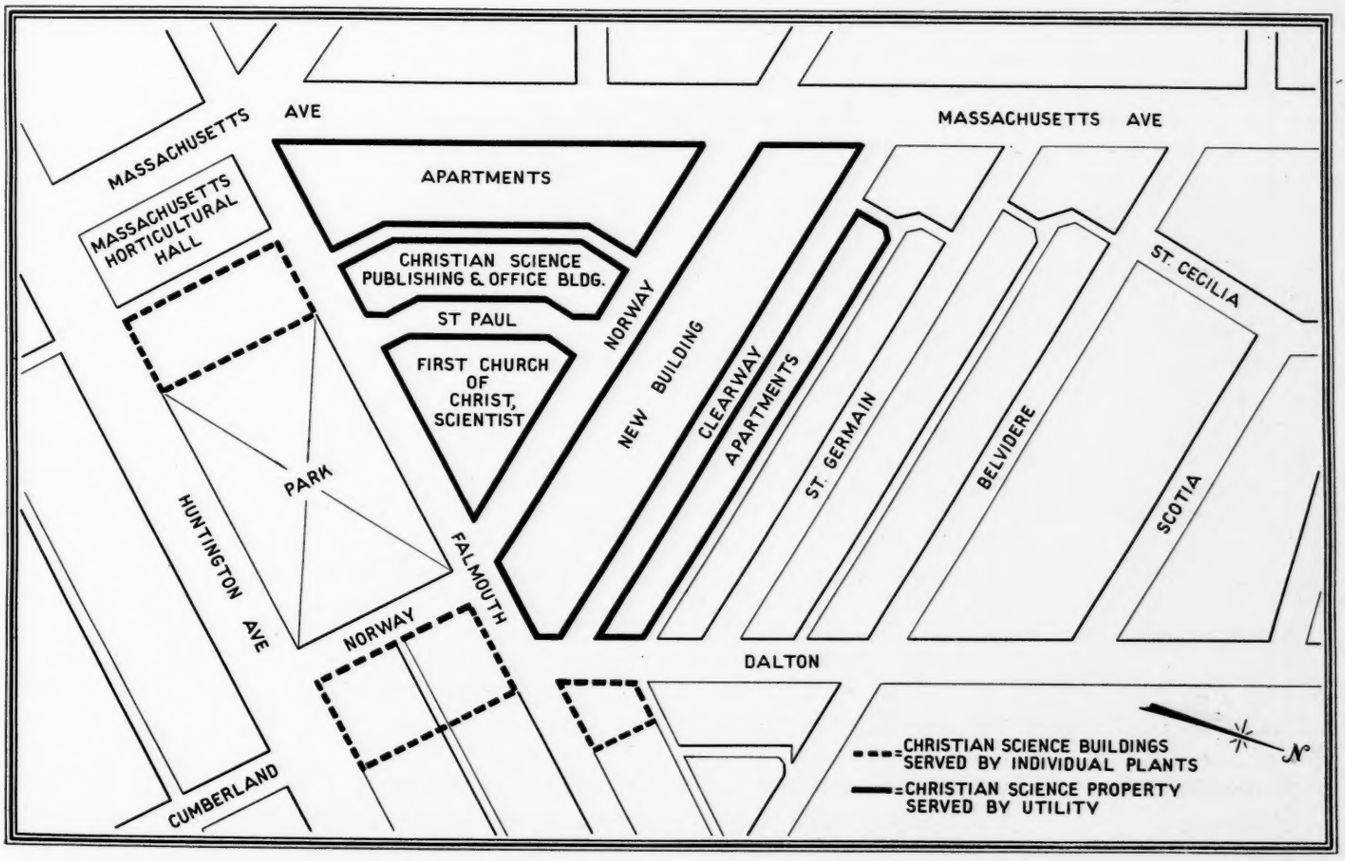


Fig. 1. Property of the Christian Science Church in Boston, Mass.

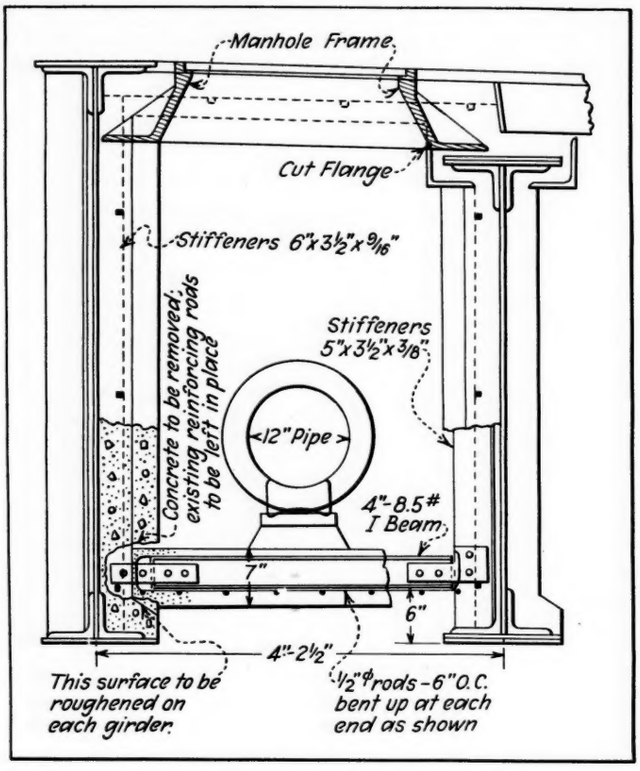
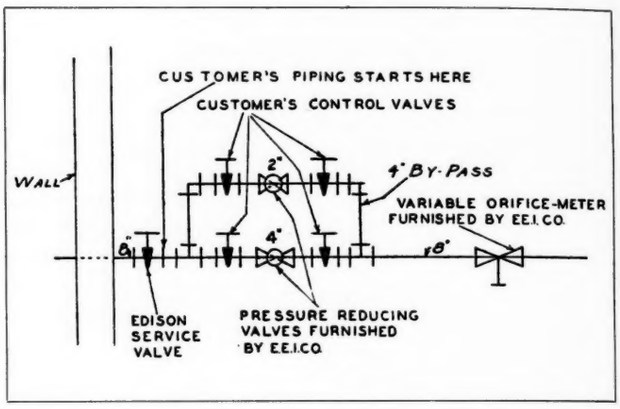


Fig. 2. (Left) Construction detail showing method of carrying steam main under sidewalk of bridge

Fig. 3. (Below) Schematic arrangement of steam service and metering piping where steam service enters customer's property



31, 1932. In order to supply steam to a new customer on the date promised, July 1, one section of 10-in. and 12-in. main, 1,700 ft. long, was installed in six weeks. Due to the leasing of privately-owned plants and the purchasing of steam from a large hotel, steam was available on each section of main as it was finished. With these mains there were also installed 15 services ranging in size from 2½ in. to 8 in. These services connected 13% of the available business en route, exclusive of the Christian Science Buildings. Including the Christian Science Buildings, 25% was connected during the first year.

Crossing a Bridge

A rather interesting problem was the crossing of the railroad tracks at a point where a bridge 85 ft. wide carried all pedestrian and vehicular traffic. The desirable method would have been to install a tunnel below the railroad tracks to effect the crossing. However, because of cost, it was decided to make an overhead crossing. There were three possibilities:

1. Building a special structure to support the pipe, independent of the bridge.
2. Suspending the pipe from the side of the bridge.
3. Installing it *in* the bridge structure.

The latter method was chosen. The bridge is built of 4-ft. steel girders. There was a bay under the sidewalk of the bridge about 4 ft. wide, in which a floor was built at the bottom of the girders, thus giving a tunnel about 4 ft. square. The sidewalk served as the roof of the tunnel, with access through a manhole cover in the sidewalk.

Throughout the rest of the steam main a poured reinforced concrete conduit with an arch-shaped galvanized corrugated metal form was used. Where the main was below the sewer, a galvanized copper bearing iron strip was cast into the base at the sidewall joint with the strip projecting up into the sidewall so that when the wall was poured about 9 in. of metal was in the side and about 6 in. in the base, to make the conduit more waterproof.

A 2½-in. fibre duct line was cast into the top of the concrete conduit to provide for future long distance pressure gauge cables for transmission of the pressure of the remote parts of the system back to the generating station.

Manholes were installed for valves, traps, and sump pumps. Wherever possible traps were installed in the same manholes as valves, but sump pumps were always installed in especially constructed manholes.

Double disc gate valves with a so-called "packless top" were used for sectionalizing. That is, there was no valve stem packing, the valve stem being made tight by a metal-to-metal "secondary seat."

Expansion

All drip piping is 1½ in. in size. Traps are 1 in., tapped for a 1½-in. inlet; 1½-in. by-passes were installed around all gate valves 8 in. and larger. Globe valves for by-passes, drip trap piping, and free blows are all flanged, and of the plug type with a special packing nut.

Expansion of the pipe was taken care of by corrugated copper expansion joints except where the direction of the pipe changed, allowing the utilization of the inherent flexibility of the pipe itself to care for the expansion. The joints have an internal monel metal sleeve and external equalizing rings to distribute the expansion uniformly over each corrugation.

Operation of the Christian Science heating plant has

been discontinued. It is planned to remove the boilers and renovate the space for other uses.

Plans for the second line, previously mentioned, forming the loop service, are well under way with the expectation that it will be in service by September 1, 1933. The second line will be comprised of approximately 9500 ft. of 8-in., 10-in., 12-in., 14-in., and 16-in. pipe.

Protecting Ventilating Motors from Burn-Outs

STANDARD motor control is designed to give adequate protection to the connected motor for normal operating conditions, but occasionally, and sometimes unknowingly, an unusual operating condition is imposed resulting in excessive heating and distress in the motor.

The critical operating condition of a motor is the actual temperature in its winding. Excessive temperature will cause a deterioration of the insulation and in time a breakdown in the winding.

For adequate protection a thermostat should be placed on the motor itself, operated in series with the thermal relay on the control, that would disconnect the motor if the actual motor temperature reached, for any reason whatsoever, a dangerous point. This would be independent of the normal setting of the overload on the control and thus permit in many cases a more accurate or correct setting for straight overload protection.

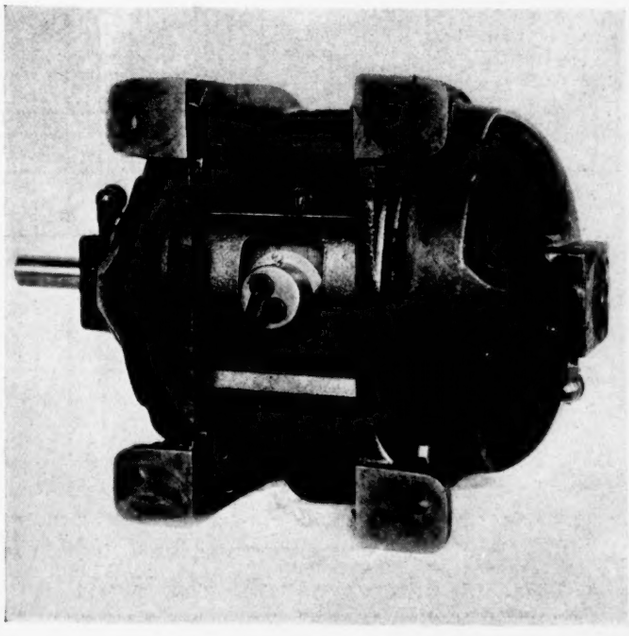
It might be thought that the operating conditions of fans and centrifugal pumps are such that the motor temperature could never exceed the normal value because these units are essentially non-overloading. It is possible, however, and has happened that a workman attempts to dry out his wet coat by throwing it over the warm motor. This naturally shuts off adequate ventilation and causes overheating. Frequently, a motor is installed in the cellar or corner and boxes piled around it until the necessary cooling air cannot reach the motor.

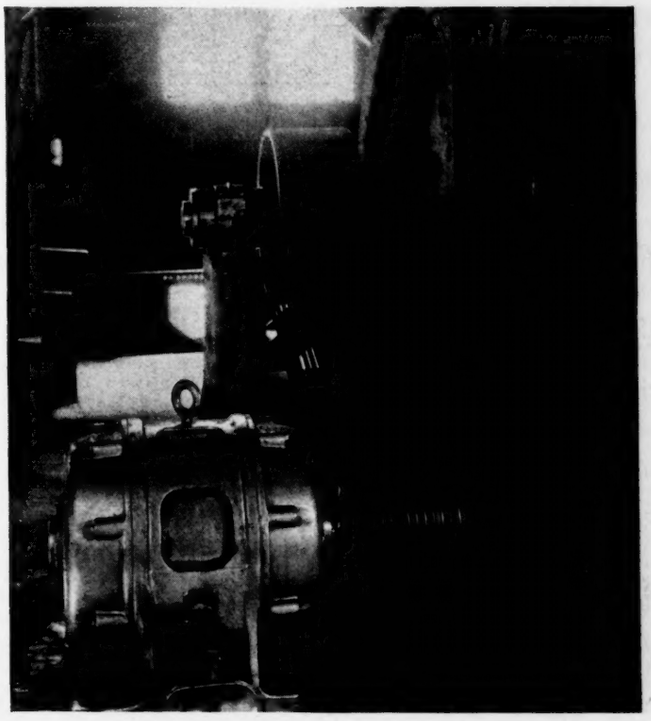
For installations of this type the motor should be equipped with a thermostat arranged to give warning, at least, before the dangerous temperature is reached.

Utility exhaust fans equipped with such a device permit their installation with less thought as to the unknown possible high ambient temperature knowing that the thermostat will give the motor adequate protection.

Another, and rather radical application of this new type of protection, is in starting large low-speed fans of high inertia where it is necessary to set the thermal overload relay above the normal rating in order to prevent tripping out during the accelerating period. A thermostat on the motor, responding to the actual temperature of the winding, can act as the overload protection and the thermal relay on the panel, which really is a current-actuated device, gives the necessary protection for unusual high current, such as a stalled motor or the like.—*R. C. Allen, General Ventilating Engineer, Westinghouse Electric & Mfg. Co.*

(Right) A thermostat on the motor solves the difficult problem of proper motor protection during acceleration of high inertia slow speed fans. (Below) How the thermostat is bolted to the active iron of induction motors.





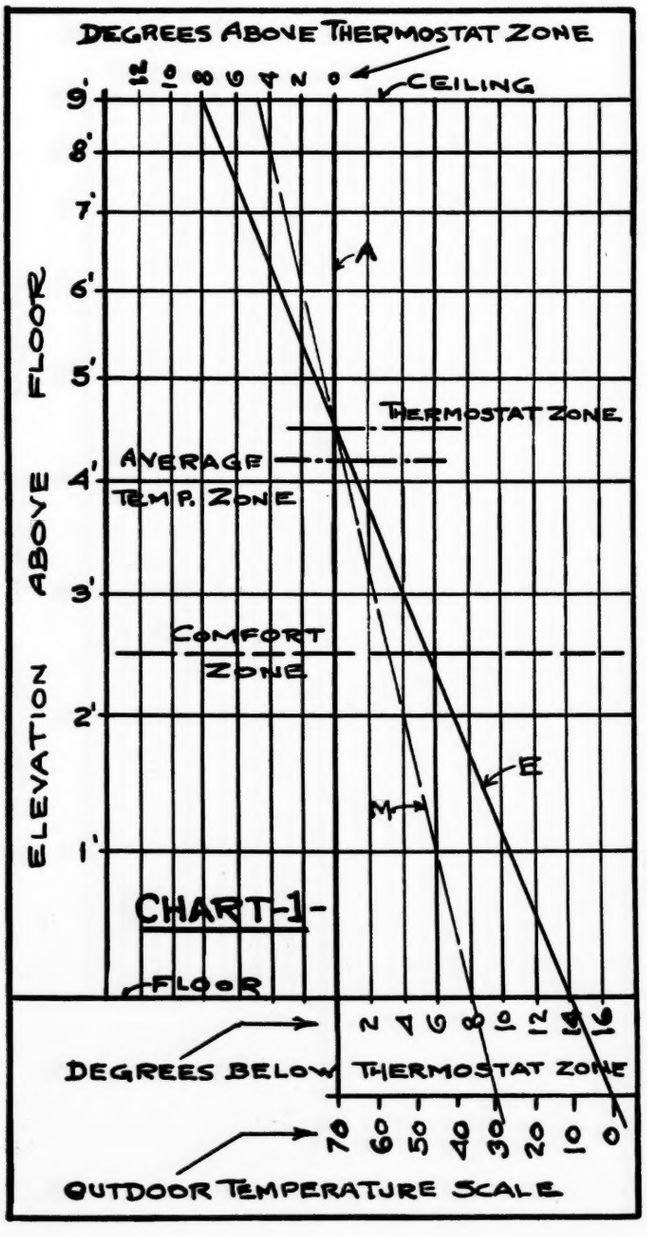
Locating Thermostats for More Accurate Temperature Control

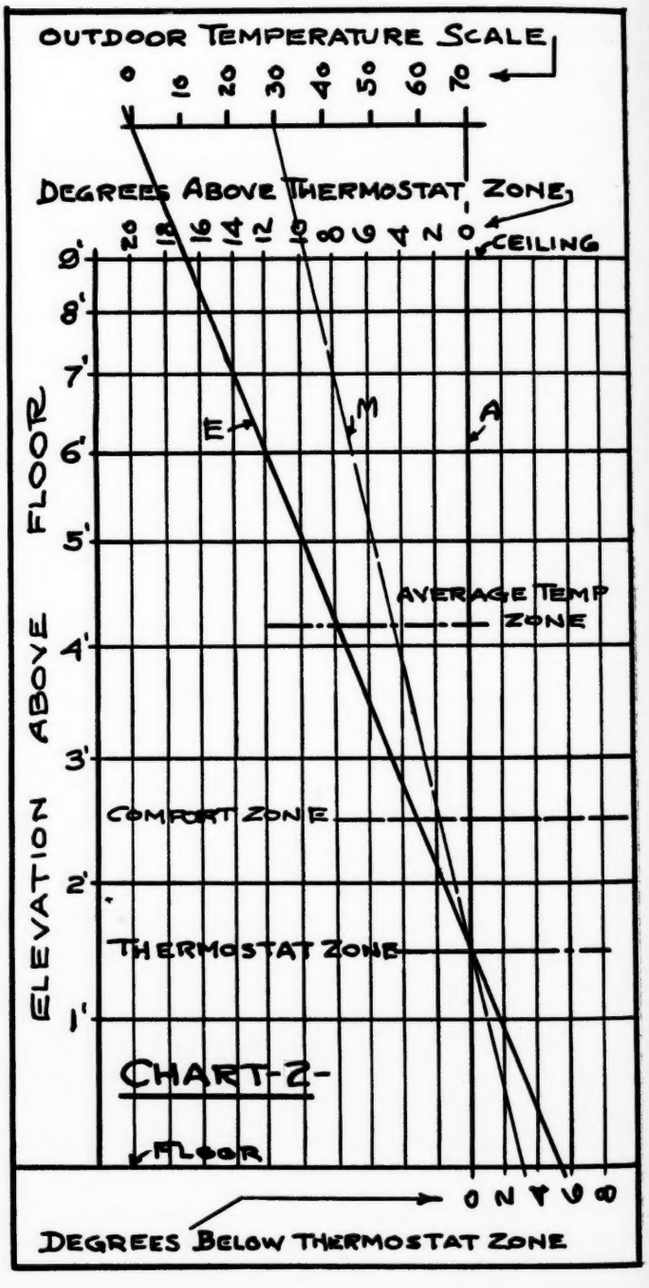
By O. J. KUENHOLD†

THE temperature in a heated room at different levels and under different weather conditions has an influence in determining room thermostat elevation which has not received adequate attention. The present-day practice of locating thermostats at about eye level —convenient for adjustment and reading of the thermometer which is commonly attached—is an inheritance from pioneer days. This practice has been rather blindly followed and it is time to question it in the light of more recent knowledge.

Chart 1 visualizes what temperature changes occur in a room under varying weather conditions. The vertical lines are drawn 2° apart and the horizontal lines represent room zones 1 ft. apart. The spacing of these

†Inventive Engineer, Cleveland.





zones indicates the extent of air temperature change per foot of height difference. The case presented is a steam-heated room in which the temperature difference from ceiling to floor was 22° in zero weather. While the conditions will be somewhat different in different cases, the principles to be explained and the conclusions logically drawn will remain the same.

The diagonal line E, drawn to intersect the vertical base line A at thermostat level, will indicate what temperature differences above and below the thermostat level will exist at different elevations above the floor when, as the outdoor temperature scale at the bottom shows, the weather is at zero. The diagonal line M, drawn to intersect the pivot point in line A at thermostat level, and 30° in the weather scale, shows the temperatures which can reasonably be expected to occur at various levels when the weather is at 30°. By swinging line M about its pivot point across any desired outdoor weather degree we can see how temperatures change at any level in response to weather changes.

It is now well known that room occupants are generally seated and therefore live principally in a zone the center of which is about 2½ ft. above the floor. It is the temperature of this zone that determines the comfort of the room occupants, and it follows that it is the temperature of this zone which should be steadily maintained regardless of weather changes.

Now, note that in 30° weather, the comfort zone is at 3° lower temperature than at thermostat level and in zero weather the comfort zone temperature drops to 5½° below that at thermostat level. It is obvious that a thermostat cannot accurately maintain desired temperature in the comfort zone when located at an elevation having up to 5½° increased temperature—the variation being dependent upon the weather.

Note further that in the representative case illustrated, with the thermostat 4½ ft. above the floor, the ceiling zone temperature varies up to 8° above thermostat setting and the floor zone varies 14° below thermostat setting.

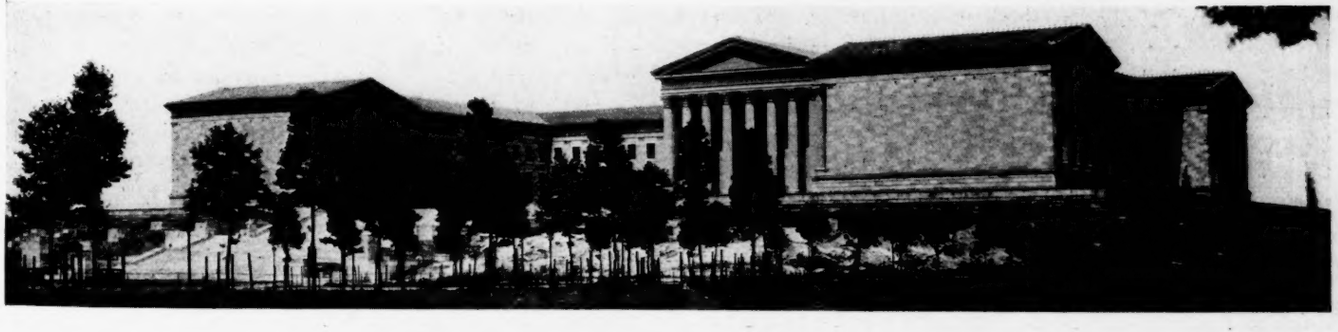
This chart plainly shows what is at the root of the "cold 70" condition. It explains why people have to doctor the thermostat setting according to the weather variations, and this should be unnecessary in a supposedly automatic heat control system. The remedy is also obvious—to locate the thermostat down in the comfort zone so that it is possible for it to maintain a comfortable and constant temperature in the zone in which the occupants live, regardless of outdoor weather changes and without the necessity for tinkering with the thermostat setting.

A still further improvement would be to place the thermostat lower than the comfort zone. Chart 2 makes the advantages of such location apparent. The outdoor temperature scale is placed above the chart in this instance. The temperature difference from ceiling to floor is the same as in Chart 1 (22°) in zero weather. Note that only small variation in floor temperature takes place in differing weather although colder weather may cause as much as 17° increase in ceiling temperature, as compared to thermostat temperature. However, so far as comfort is concerned, we are not interested in ceiling temperature variations.

Naturally, with the thermostat located at lower level, it can be set at a lower temperature that results in comfort equalling that occurring in moderate weather when a thermostat at 4½-ft. level would be set at 70°. Such a setting may be 66° or 67°. In 35° weather this would give about 68° at the comfort zone, but note that when the weather drops to zero the temperature at comfort zone would automatically be advanced 1° or 2°. This would automatically compensate for the effect upon comfort of the "cold radiation" of glass surfaces and for stray cold currents.

Naturally, there will be arguments against such a radical departure from accepted thermostat location. Wrong first conclusions can easily be drawn but they will not hold water upon mature consideration. Remember that the thermostat cannot in anyway control temperature differences between ceiling and floor. That is distinctly the province of designers of heating systems and appliances, and can be remedied by reducing the air discharge temperature of registers, radiators, and heaters, and increasing the air volume. The greater the temperature difference between ceiling and floor, the more important it is to locate the thermostat at lower level.

The response of the thermostat is much more rapid to room cooling when located at low level, because rooms cool from the bottom up. The response to room heating will naturally be slower because rooms are heated from the top down. Provisions against this must be made, especially in systems which incorporate a considerable heat reservoir between the source of heat and the room. The basic fact still remains that thermostats cannot accurately maintain desired comfort zone temperature if located at appreciable distance above it. The rest is detail.



EDITORIALS

Do Your Thinking Now

WITH some form of control or self-regulation almost certain to be applied to industry and trade, it is high time that every engineer and contractor give consideration to how it may affect both him and his business.

No matter how one approaches the subject he will find that at present it is almost impossible to get accurate information or to learn how far the proposed legislation is to go. In general, he will find that the proposal is intended to be permissive in character and that unless there is concerted action between him and his fellows, passage of the act will have no direct effect on him at all. If other groups decide to accept its provisions, however, he will come into contact with the effects of the law indirectly in that he is likely to have to pay higher prices for some commodities.

Reduced to its simplest terms the idea is easy to follow. As an example, suppose that the law is in effect and that a certain heating contractor feels that he and his competitors are cutting each other's throats by price-cutting and that all would gladly stop this if a way could be found. He could go to the others and propose that they draw up an agreeable code and form an organization or sign an agreement setting forth the practices they would follow. If a few held out they could be brought in line under the terms of the act.

While this elementary example illustrates the general plan, it does not show what would actually happen in practice for the cases would not be simple or elementary but extremely complex. The complexity in actual practice is what makes the whole subject of such absorbing interest and is why predictions as to its effects are almost entirely worthless. It also explains why we urge that it should receive serious thought now. There seems to be a feeling that the act applies only to manufacturing groups. This may be due to the fact that in nearly all public discussions these groups have been used as examples in explaining the proposal. With the general obscurity of details as to how far the provisions of the act may be carried there will be room for promotional organizing and it can be confidently predicted that this will be practiced. With the act passed it seems certain that movements will spring up to organize every conceivable group on almost every thinkable practice. Attempts will surely be made to organize salesmen, agents, dealers, contractors, engineers, and others, as well as manufacturers. If one lends support to promotional organizations he may find that he is bound up in an agreement not to his liking. Staying out of another one may mean that he will find himself identified with a recalcitrant minority group. The decision will usually be hard to make.

Sooner or later nearly everyone in business will have to decide with which organized groups he will associate himself and with which he will have to disagree. Now is the time to be considering both what unfavorable practice he feels can be eliminated by self-regulation, and whether he wants to identify himself with existing trade associations or feels that new ones would be best.

Through the whole discussion thus far runs the thought that happy is the group which already possesses a strong trade organization well conceived and well directed with a majority membership among those of its interest. Such groups stand in a favorable position in that they can quickly take advantage of any real privileges while they need not be stampeded.

Keeping Cooling in the Industry

ROOM cooling cabinets continue to appear on the market. There have been a number of new ones within recent weeks. Entry of each additional one means not only that competition for the available business becomes keener, but it is worthy of note that a few of them are planned for sale through new channels.

If the existing channels are to maintain their position they must both accept this condition as a definite trend, and be prepared to defend their claims to consideration. The best way to make a new manufacturer want to stay in existing channels is to make it worth his while to do so. If every heating engineer and contractor was known locally as *the* man to see on cooling as well as on heating problems, he would be in demand in such cases. If he is not so known we wonder who is at fault.

Building cooling is certainly coming in one form or another, and probably coming fairly rapidly. There is no point in ignoring its progress. Neither is there any better time than now to brush up on existing equipment and practice, to make contacts, and to lay the foundations of a reputation as *the* man to be consulted.

Trend

AN encouraging recent trend has been the better quality of printed instruction booklets and catalogs which have appeared in our industry. What brings this observation to mind especially is the appearance of some booklets on the application of air conditioning apparatus which really carry information. This cannot be said about much of the earlier material alleged to be for this purpose.

Reading some of the earlier ones and some of the later naturally led to thinking about how much improvement has taken place. From this it is but a step to start speculating on their nature.

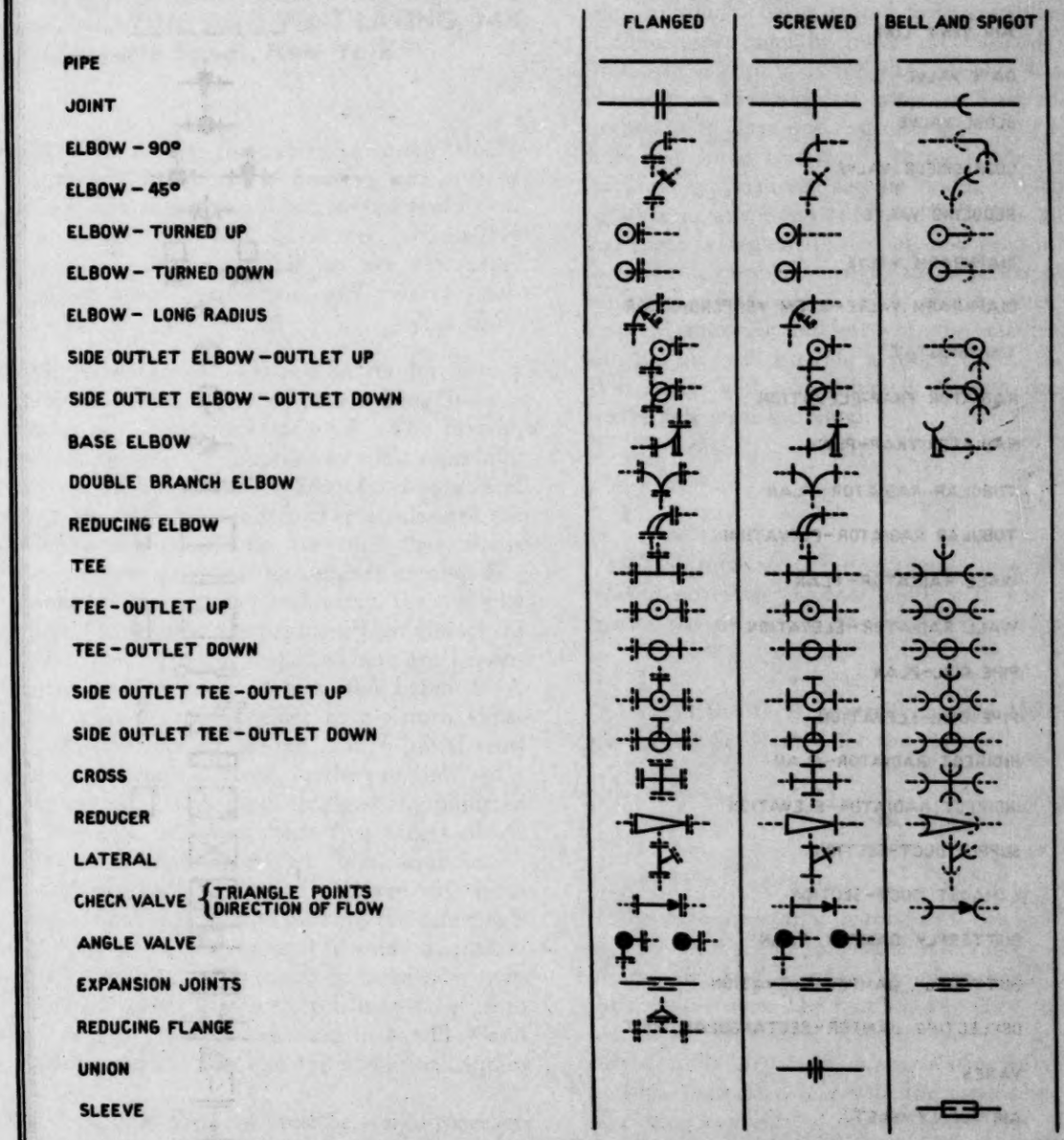
Typography and appearance account for a good deal —for enough in fact so that printed selling material is now so generally good that a poorly laid out piece is noticeable. Good composition makes the important material stand out. Color is probably no less used than formerly but now its use is more effective. Sketches are usually both clear and understandable. There appears to be an increasing understanding of what the user wants and a real effort to supply it. Harder selling accounts for the increased attention and results will probably be apparent soon.

DRAFTING ROOM SYMBOLS

CONVENTIONAL symbols for drawings relating to pipe, pipe fittings, and heating and ventilating equipment are given below and on the reverse side of this sheet.

The status of these symbols at this time (May, 1933) is that they are tentative standards of the American Standards Association. Presumably, changes which will be made prior to their complete adoption by the A S A will be slight.

PIPE AND PIPE FITTINGS SYMBOLS



DRAFTING ROOM SYMBOLS

HEATING AND VENTILATING SYMBOLS

HIGH PRESSURE STEAM PIPE

LOW PRESSURE STEAM PIPE

HOT WATER PIPE--FLOW

RETURN PIPE-STEAM OR WATER

AIR VENT LINE

GATE VALVE

GLOBE VALVE

LOCK SHIELD VALVE

REDUCING VALVE

DIAPHRAGM VALVE

DIAPHRAGM VALVE-STEM PERPENDICULAR

THERMOSTAT

RADIATOR TRAP-ELEVATION

RADIATOR TRAP-PLAN

TUBULAR RADIATOR-PLAN

TUBULAR RADIATOR-ELEVATION

WALL RADIATOR-PLAN

WALL RADIATOR-ELEVATION

PIPE COIL-PLAN

PIPE COIL-ELEVATION

INDIRECT RADIATOR-PLAN

INDIRECT RADIATOR-ELEVATION

SUPPLY DUCT-SECTION

EXHAUST DUCT-SECTION

BUTTERFLY DAMPER-PLAN

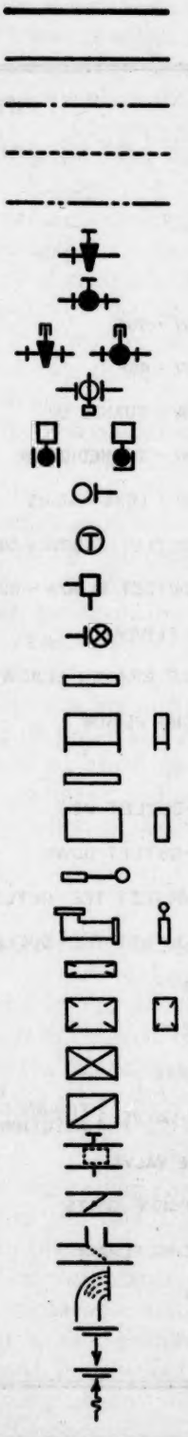
BUTTERFLY DAMPER-ELEVATION

DEFLECTING DAMPER-RECTANGULAR DUCT

VANES

AIR SUPPLY INLET

EXHAUST OUTLET



H. & V.'s REFERENCE DATA—12

Your Everyday Problems

HEATING AND VENTILATING will be glad to answer your problems relating to installation and operation of heating and ventilating systems. Letters will be answered promptly, and in some cases published anonymously. If sketches are included they should be clearly drawn. Write The Editor, HEATING AND VENTILATING, 148 Lafayette Street, New York.

QUESTION 85. *During the winter, what might have been a disastrous fire in a school building was averted when we discovered that a pile of bituminous coal stored in a bunker in the cellar had caught fire, presumably from spontaneous combustion. What are the usual causes of spontaneous combustion, and what precautions can be taken to prevent it?* *J. A. E.*

ANSWER: Spontaneous combustion results from a concentration or accumulation of heat arising from a slow oxidation of combustible material. The carbon, sulphur, and hydrogen of bituminous coal, especially when newly mined, has a strong affinity for oxygen, and this reaction liberates heat and further accelerates the reaction. When the conditions are such that air is present in sufficient quantity to support combustion, but not enough to conduct the heat away, the coal pile will be heated locally to a temperature high enough to ignite the coal, and a fire will result. There are a number of factors which tend to increase this liability. A high sulphur content, the presence of moisture, especially alternate wetting and drying, a high initial temperature when the coal is stored, or the proximity of a furnace, smokepipe, steam pipe, etc., and the piling of porous or fine coal, which permits free access of air without ventilating effect all work to bring it about.

This hazard is always present to a degree with bituminous from certain regions, and perhaps the safest rule to follow is that of buying the coal in small quantities so that it will not have to be stored in large piles over a long period of time. However, you may be reasonably safe if ordinary care is exercised in handling and storing, and if a careful check of the conditions within the pile be kept.

If mixed lump and fine coal must be stored together, the various sizes should be evenly distributed so as to prevent the formation of air passages through segregated portions of the large sizes. When stored indoors, the pile should be in a fireproof bin and removed from the boiler by a reasonable distance. The height of a flat topped pile should not exceed 6 ft. if the coal is of the lower grades, and should never be more than 12 ft. It is well to avoid the storing of coal during hot weather, and the coal should not be handled or stored during wet weather. It is also advisable when space permits, to store the coal in piles in the form of long narrow ridges, separated by open spaces, to permit air cooling, and dissipation of heat by radiation.

There are several methods by which the temperature of the interior of a coal pile can be checked. In large piles, in which coal is stored for a considerable length of time, pipes may be placed at intervals, extending down to the bottom of the pile, into which a maximum temperature thermometer may be lowered. Another method is to close one end of a pipe with a sharpened plug and force this down through the pile so that thermometer readings can be taken. When the temperature at any point reaches 150°, it is an indication that there is immediate danger, and precautions should be taken at once to uncover the location of high temperature. Iron rods or pipes driven into the pile at frequent intervals, and left with the ends projecting out into the air, will provide a rough check, as heat from local points will be conducted through the metal and can be felt with the hand.

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QUESTION 86. *Is it advisable to drain the water from a hot water system when it is not in operation during the warm months in order to stop corrosion?* *L. J. F.*

ANSWER. It is generally agreed that the system should not be drained for the summer.

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QUESTION 87. *It is an accepted fact that a relatively high humidity maintained indoors during the heating season will promote comfortable conditions with a lower dry bulb temperature than would be necessary for comfort were the relative humidity low. In other words, an individual feels warmer in a room maintained at 70° dry bulb with a relative humidity of 35% or 40% than he would with the same temperature and a relative humidity of say 15% or 20%. Why then do we frequently hear it said in winter that one doesn't mind the cold out of doors in a certain locality because the air is dry? The two ideas seem contradictory, and yet experience would seem to bear out their accuracy.* *W. A. E.*

ANSWER. At the normal temperature of a heated interior, evaporation of moisture from the human body is a major factor effecting the rate of heat loss from

the body, since the temperature differential between the body and the surrounding atmosphere and radiating surfaces is not large. It is easy to understand, then, that as the rate of evaporation is retarded by an increase in relative humidity, a greater feeling of warmth will result, other factors remaining constant.

At low outdoor winter temperatures, however, evaporation from the body practically ceases, and is accountable for a very minor part of the heat lost as compared to that removed by convection and by radiation to surrounding surfaces, which are at a considerably lower temperature than that of the body. On the other hand, loss of heat from the body is increased by the presence of moisture in the air at low temperatures since it renders the air a better conductor of heat and increases its ability to absorb radiant heat, increasing the rate of heat transfer from the body to the air.

In the light of this discussion, it would appear that there must be some temperature, or range of temperatures, for which the relative humidity has no effect upon the feeling of warmth experienced by an individual. This has been found to be the case. The transition point at which the relative humidity has no effect on comfort is in the neighborhood of 46° for still air, becoming higher as the air velocity increases.

Camel Milk

By Ab-El-Pilauf

A new Caliph came to Bagdad. Taking office under the despairing glances of the oppressed, he grasped the reins of power with a quick, sure hand. The marts of barter and haggle had long since ceased to echo to the fruitful sounds of commerce, and the Caliph vowed to give the sons of the profit a new deal.

The sons of the desert had heard much of promise. So having little else to engage them, they made hegira to the temples of the money changers and demanded their shekels in a body. Whereupon the Caliph sealed the doors of the money changeries, while he made oration: "Thy shekels are safe in the custody of these thy servants, but if any prove faithless, I shalt off with his head and I shalt then pay thee what he owest out of my exchequer." Whereupon, such is the manner of his subjects, they vanish from the money changeries and wanted not their shekels.

Then the Caliph decreed that camel milk could be quaffed from camels that had grazed on hop bushes that had grown three and two tenth cubits from the ground.

For many moons the camel milkeries had been a sour stench in the law-abiding nostrils of the faithful. For they had openly derided the law of the land that sought to protect the hop bush, that henceforth it should be an insult to Allah to permit a camel to graze on a hop bush that grew higher than five tenths of a cubit. But woe had descended upon the law. The camels cared naught for the decree and grazed merrily on hop bushes that grew to wicked heights. The faithful quaffed of their milk in increasing numbers and were much exhilarated thereby. For it was written that milk from a low bush containeth no whoopee.

When the Caliph raised the grazing height, the faithful made holiday and whoop-de-do and the camels were run ragged to supply enough milk. And lo, faint yammerings of industry were heard in the market place. The faithful took a new interest in enterprise and those who had waited for Allah to push fresh shekels into their laps grew weary of waiting. Seeing that their new Caliph gave them what they wanted, they quit wanting and got themselves busy.

Serenely, the Caliph went his way. He jibed the soothsayers and derided the pessimisticrats. Nimbly he cavorted from promise to action and the faithful grew dizzy from much effort to keep pace with him. Soon much muttering was heard in the bazaars. Buyer and seller and mendicant and artificer sought to fill their needs and the flow of commerce, from a thin trickle, soon boomed forth into a flood.

Then the faithful sought audience with the Caliph and prostrating themselves before him, besought him to tell them the secret of his magic, so that nevermore should woe decend upon the land.

But the Caliph denied his witchcraft. "It is simple," said he, musingly. "Perform thy promises, but be sure that thou canst perform."

And each man did as the Caliph said—and the wheels of progress whirled profitably ever after.

Abstracts . . .

**Reviews and Summaries of. . . .
Current Papers, Books and Pamphlets**

Studies Show No General Effects from Breathing Hot Air

When subjects sitting at rest in a cool environment breathe hot moist air, the limit of tolerance lies between 140° and 150° (wet bulb). When doing work, the tolerance limit falls between 130° and 140° (wet bulb).

The local effects noticed are a transient sensation of burning in mouth and throat and reddening of palate and throat. With those at rest, there is an increase with some irregularity in the respiration rate. With those doing work, sweating is noticeably greater when the wet bulb temperature of the inspired air is above body temperature.

The limits of tolerance for subjects at rest and breathing hot dry air lie between 270° and 367° (dry bulb); corresponding limits for those doing work lie between 200° and 220° (dry bulb).

The local effects of breathing hot dry air are extreme dryness of mouth and throat with a slight sensation of burning in some subjects, frequent coughing, and slight reddening of palate and throat.

No general effects were observed as a result of breathing hot dry air.

[*Title: "Physiological Response to Breathing Hot Air," by Esther M. Killick, University of Leeds; Journal of Hygiene, Great Britain; July,* 1932].

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Recent Developments in Great Britain

There are many differences in the art of heating and ventilating as practiced in Great Britain and as carried out on this side of the Atlantic, and a paper recently presented before the Royal Society of Arts, in which the subject is comprehensively surveyed, contains much that should interest an American engineer. It is purely qualitative exposition, touching on historical phases as well as modern treatments.

Warming by convection and radiation are discussed, the author apparently favoring the latter method as accomplished through panel heating. Various types of installations are described, and it is stated that cooling has been carried out successfully by this method. Ceiling surface has been cooled to within less than 1° of the dew point without condensation. The degree of comfort so obtained is said to be superior to that indicated by the dry bulb temperature, due probably to vertical air currents.

Temperature control is discussed at some length, with the various methods mentioned. In addition to improved efficiency of occupants, the author believes that a 25% saving in fuel will be realized with adequate automatic control.

Concerning thermal storage, the author says that it may prove profitable to store heat at times when power is cheap for utilization in subsequent periods when power is more expensive, as may be the case with electric heating. It may also be economical where a plant must be operated 24 hr. a day, in which case the saving achieved by the elimination of one or more shifts from the operating staff, and by confining the flue losses to a single firing period, may offset the increased cost of equipment, and the heat loss in storage. The author further states that it might be desirable to store heat during the day when the noise of the firing equipment in operation will not be so objectionable as it would be at night. It is his opinion, however, that in the average case, continuous heating is the more economical.

The paper concludes with a discussion of ventilation, in which are included dissertations on humidification, washing, and filtering, in which very little difference from our own practice is noted.

[*Title: "Recent Developments in the Heating and Ventilation of Buildings," by J. L. Musgrave, past president I.H.V.E. Read at 15th ordinary meeting, Royal Society of Arts, March* 8. *In Journal of R.S.A., April* 14, 1933; *approximately* 15,000 *words; no illustrations; two temperature-time records.*]

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Air Conditioning Costs

Complete air conditioning equipment has been in continual operation in the 10-story office building of the San Joaquin Light & Power Corp., Fresno, Cal., since the time of its construction nine years ago. After watching the performance of the installation over this period, the company reports complete satisfaction and believes the additional expenditures entailed by it to be justified.

The building has 1,200,000 cu. ft. of space and a floor area of 101,800 sq. ft. The total cost of the structure and its equipment was $1,200,000, of which $122,000, or 10.89%, represented the air conditioning system, including heating, ventilating, washing, and cooling. It was estimated that the heating system alone, necessary even in the mild climate of Fresno, would have cost $60,000, equivalent to 5.35% of the total investment. Estimated cost of the ventilating system alone was $33,875, or 3.02% of the investment, and the cooling system alone cost $28,165, or 2.52% of the whole. The cost of the cooling was rather low compared to the other items, considering that mechanical refrigeration was necessary.

During the cooling season of 1921, the kilowatt-hour consumption was 196,720, and 20,233,698 gal. of water were required for the ammonia condensers. The inside

temperature was maintained at 18° below the outside temperature, but was never permitted to fall below 70°, relative humidity between 40% and 45%. Total heating and cooling costs for 1931 follow:

	Heating	Cooling	Total
System operation and maintenance	$5,097.00	$7,442.65	$12,540.16
Ventilation (prorated)	850.13	997.97	1,848.10
Interest on investment	4,200.00	1,971.55	6,171.55
Depreciation	1,200.00	563.30	1,763.30
Interest on ventilating equipment (prorated)	1,090.74	1,280.44	2,371.18
Depreciation on ventilating equipment	311.64	365.84	677.48
Total	$12,750.02	$12,621.75	$25,371.77

This shows the operation of the cooling system to cost slightly less than the operation of the heating system. Benefits of this cooling system acknowledged by the owner include increased morale and efficiency and improved health of employees. The building has been kept modern, depreciation and maintenance in the structure have been reduced to a minimum, and janitor service has been lessened, since air washing has resulted in less cleaning being necessary.

[*Title: "Air Conditioning Costs Analyzed," by G. E. Zelhart, sales engineer, San Joaquin Light & Power Corporation; in "Electrical West," April,* 1933; *approximately* 750 *words; tables and charts.*]

●

Vocational Guidance in Engineering Lines

Vocational guidance in engineering has been almost totally non-existent. Boys drift in and out; the spread between college entrance and graduation is so great as to be beyond belief unless one is close to the actual situation. Here and there attempts have been made to help this condition. Individuals have tried to offer advice in isolated cases and some organized efforts have been made to acquaint young men and their parents with the facts of engineering practice, but the results have been disappointing.

Recognizing, evidently, that a clearly-written book on the subject would further such efforts and might help to direct them, the American Association of Engineers has not only lent its good offices to further the appearance of such a book, but has actually succeeded even in these troublesome times.

The general plan is to have sections, or chapters, each covering some engineering branch of specialty and written by an author of recognized worth. Each chapter thus covers much the same ground, setting forth the limits of the field, the kind of work available, the qualities which a young man is likely to find necessary in order to get along in it, and sometimes a statement of what he may expect in return. Naturally, such a plan leads to a considerable amount of repetition of thought but has the advantage of making the story about each branch stand out as a unit.

A simple style is used throughout with the idea of making the book appeal to young men. At the same time the parent must be interested, and informed as well.

Engineers will find it possible to quarrel with many details of the book if they are so inclined. The distribution of space to the several specialties leaves considerable question as to why structural and other civil engineering branches are so greatly favored. One would gather the idea that there is no such animal as an engineer who devotes his principal attention to heating and ventilating, for example. However, space distribution and emphasis of subject matter are items which can be overlooked if the real purpose of the book is accomplished. It strikes a subject on which there is a real need of material, and is well worth reading, especially by those who have sons at the guidance age.

[*Title: "Vocational Guidance in Engineering Lines," published by the American Association of Engineers. Cloth-bound; 6 in. × 9 in.; 521 pages, well illustrated. Price $2.50, obtainable from The Mack Printing Co., Easton, Pa.*]

●

Insulating Old and New Houses

Building insulation has come into such general use that pamphlets dealing with it are not appearing as frequently as they were a few years ago. The publication of the Canadian government bearing on the subject shows the results of the experience gained, for these materials are neatly classified and their applications are described with many illustrations taken from actual jobs. The material is almost wholly non-technical in character and takes up insulating materials and application methods under the heads of new and old houses separately. Anyone who wishes a general summary and review of insulating materials and practices will find the pamphlet interesting reading.

[*Title: "The Insulation of New and Old Houses," by G. D. Mallory; published by the National Development Bureau of the Department of the Interior, Dominion Fuel Board cooperating. Copies obtainable by addressing either the Bureau or the Board at Ottawa; price not stated. Paper-bound pamphlet, 73 pages, 6½ in. × 9¾ in., illustrated.*]

●

Difficulties of Design in Railway Car Air Conditioning

Space limitations on railroad passenger cars are severe. They cramped attempts to design a suitable air conditioning unit for this service to an extent that made it necessary to work out innovations. Space limitation is the central theme of the story of the design of this Westinghouse unit, which is told item by item.

Capacity calculations did not agree with the capacities found necessary in practice and the six tons of refrigeration to be delivered to the cooling coils of the average car were found from experience.

The drive problem was difficult and the final device adopted used a belt. Belt speed was kept low by building a speed reducer into the generator. Generator space could be found only by using a high peripheral speed to obtain the desired rating. Ventilating fins were cast into the casing in order that any air movement over the car frame could be used to help cool the

generator. Constant polarity and satisfactory battery charging presented aspects which called for special design.

Space limitations were especially severe in designing the refrigerating box. A high speed compressor having a strip-steel valve was used in the final unit and freon was the refrigerant selected. Use of water for condensing was eliminated by selection of a condenser which would fit into the space allowed. A suitable propeller fan for use with the condenser was found only after intensive effort as the dimensions were severely restricted. Electrical current available at terminals being a.c. it was necessary to provide a combination a.c. and d.c. motor with a common shaft. This was accomplished within the space occupied by an ordinary d.c. motor of the same capacity.

[*Title: "Application of Air Conditioning to Railroad Passenger Cars," by W. C. Goodwin and Charles Kerr, Jr. Presented before the winter convention of the A.I.E.E., New York, January,* 1933; *approximately* 3000 *words,* 4 *illustrations.*]

●

Relation of Air Conditioning to Heating

In spite of the relationship between heating and refrigeration, few papers have been published which have taken this relationship for a theme. The present author in his paper before the Western Society of Engineers dwells on the relationship and explains it from several angles. Not only are the two fields akin in the problem of heat transfer, but reversal of the refrigeration cycle permits its use for heating. Air conditioning may involve both.

After a discussion covering the essentials of air conditioning as he sees them, the author passes on to some commercial aspects and presents the case of the established heating trade for consideration in marketing plans. He points out the importance of good installations and adequate engineering to ensure success of air conditioning installations, and extends his parallel with refrigeration by calling attention to some of the disagreeable results which followed early attempts to rush refrigeration to the market without adequate size and proper construction precautions. He hopes that engineers will lend their influence to see that like ill-effects may not follow hurried marketing of air conditioning apparatus.

[*Title: "Refrigeration and Air Conditioning Points in Common," by D. E. Perham; paper before Western Society of Engineers and published in Journal for April,* 1933. *Approximately* 3000 *words, unillustrated.*]

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Construction and Humidity Affect Infiltration

Tests to determine the amount of air which flows through the cracks around windows have shown that the amount is exceedingly variable. Results obtained depend both on the testing method used and on the window construction. The study at the University of California tends to confirm these findings and also shows that methods of fastening and relative humidities of the air are also factors in the amounts of air measured.

Pressure across steel swing and hung windows were set up by artificial means in a laboratory and computed to equivalent wind velocity. Means of obtaining both dry and saturated air were available and the humidity was controlled during some of the tests when a felt weatherstripping was used.

The results obtained were plotted in a chart with those obtained by other investigators, and the total variation between window constructions and test methods is pointed out to be 1400% at 25 m.p.h. Also at 25 m.p.h., variations of 15% were obtained depending on the method of closing and latching. Leakage for steel hung windows differed when ascending and descending pressure differentials across the windows were used. On the felt weatherstripped window with a 25 m.p.h. velocity, variations of 140% in leakage were found when the air used in the testing was changed from dry to saturated.

Results of the authors' tests are analyzed mathematically and the discussion constitutes a considerable part of the paper.

[*Title: "Air Infiltration Through Steel Framed Windows," by D. O. Rusk, V. H. Cherry, and L. Boelter. Presented at the A.S.H.V.E. annual meeting, January,* 1933; *approximately* 2500 *words, illustrated.*]

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Canadian Engineer Suggests Changes in Heat Loss Computation

Heat lag, heat capacity, or heat fly-wheel effect are terms which are often heard but about which little has ever been done in heating or cooling practice in determining plant capacity. Now comes a Canadian who is convinced that these factors are of enough importance to justify modifications of heat loss computations. He offers concrete evidence from his experience that he has been able to heat certain buildings successfully with radiators much smaller than those usually installed, and also suggests a modified method of computation.

The examples which he cites are all Canadian buildings and are thus located where winter temperatures are severe. One was an unheated one-story packing shed about 180 × 50 ft. in plan and built of a construction which used a 4-in. gypsum fill in sidewalls and flat roof. Another was a small office building, while a third was an eight-room bungalow in Quebec.

In the unheated packing shed the inside temperature fell to as low as 30° on only six occasions during a period when the outdoor temperature fell to zero or below 14 times. The longest period of 30° indoor temperature lasted only 24 hr. and followed a drop of from 10° to — 17°. As 30° is thus the inside temperature in extreme weather without any heating plant at all, the author feels that a plant sized on the usual assumption of a 70° temperature would be entirely too large. He suggests that in such buildings a suitable sizing procedure would be to use a temperature difference of 70° minus the observed temperature without heating. If this were done in the case of the packing shed, the installed plant would be approximately half the size of

the one installed if the usual rules are followed.

In the small office building observed by the writer of this paper the amount of radiator surface as computed by usual methods was cut about one-third prior to the heating season of 1929-30. During that season it was observed that there seemed to be ample capacity. Prior to the 1931-32 season a further reduction of about one third of the remaining surface was made, and the boiler capacity was reduced. Again the reduced capacity seemed adequate, for, during one period, the indoor temperatures were ample except in one room at the top of the building, and it seemed that this could be corrected either by adding heating surface or by providing greater heat-retaining construction.

In the bungalow in northern Quebec the writer states that on January 4, 1930, with a temperature of — 12° outdoors, only 67 sq. ft. of heating surface were needed to keep a 70° temperature in the living room of this steam-heated 38 × 46 building which was of frame construction with insulated walls, floors, and ceiling but without weatherstripping.

The following are among the conclusions listed by the writer:

1. Under the extreme variations of temperature in Canada and the northern states, the most important factor in determining heating plant size appears to be the outdoor temperature assumed, particularly when well-insulated types of construction are used.
2. Estimates of annual fuel consumption based on outdoor mean temperatures obtained from instruments shielded from the sun (as is the case at most of the Canadian Government Weather Stations) are likely to be seriously in error.
3. More attention should be paid to balancing the heat retaining capacity in all parts of a building, so as to avoid the necessity of providing a large, uneconomical reserve in heating plant capacity for only rare emergency use.
4. The fact that an indoor temperature of 30° or higher has been maintained in buildings without any artificial heating plants for three consecutive winters, where the outdoor temperatures have dropped to — 20°, and also that 70° has been recorded indoors without artificial cooling when the outdoor temperature was 90°, indicates the need for further investigation to provide reliable data on the fly-wheel effect of different types of construction.

[*Title: "Some Observations on Heating Practice," by James Govan. Presented at the A.S.H.V.E. annual meeting, January,* 1933.]

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Unit Heaters in Railroad Repair Shops

In a paper devoted largely to a general discussion of various heating methods and an elementary discussion of unit heaters, the author presents some interesting observations on the application of the latter to the heating of railroad repair shops, engine houses, etc.

In these structures, generally designed with large roof openings to permit the egress of smoke and fumes, and with large outside doors to admit rolling stock, the natural circulation of air is such as to oppose the usual circulation of warm air by unit heaters as conventionally installed, with the warm air discharged at a considerable height above the floor. For this reason, the best results are realized with the cold-air intake located at the top of the working zone (not more than 7 ft. above the floor to avoid recirculation of fumes) and with the warm air discharged at the floor line or into the pits.

Satisfactory results have been obtained with unit heaters located in extensions at the ends of the pits. This installation, however, necessitates the use of underground piping, and heaters so located are subject to damage by water, either from boiler washing operations, or from faulty drainage. The author recommends manual control for heaters so that the temperature can be regulated locally by those working in the pits. For the same reason, dampers should be installed to divert the flow of warm air in cases where the unit heater discharges into the pits from a duct.

[*Title: "Use of Unit Heaters in Shops and Engine Houses Has Advantages," taken from a report of the Committee on Shops and Locomotive Terminals, read at the convention of American Railroad Engineers Association, Chicago, March* 14, 15; *approximately* 1000 *words, no illustrations, charts, or table.*]

●

Vacuum Returns Should be Sized at 150% of Standard Flow Size

For some time the A.S.H.V.E. research laboratory has been studying the flow of air and condensate in the return lines of heating systems. Considerable laboratory work has been completed in an effort to isolate the separate factors in order to rationalize the sizing of piping. This laboratory work has been extended to the field, and the results of studies on a gravity-flow steam system in a 12-room residence and on a vacuum system in a part of a large office building are now available.

Data on 11 tests are reported. They were made under controlled conditions intended to bring out the characteristics at maximum operation in order that the results might be used for design purposes. Curves show that in the installations tested the maximum flow of air did not take place at the same time as the maximum flow of condensate. As a result of an analysis of the test data it is tentatively concluded that return piping for vacuum systems be based on "a maximum condensation load during the heating-up period of 150% of the designed condensation load under standard conditions, and a ratio of 0.10 cu. ft. of air per pound of condensate" with suitable allowances for volumetric capacity depending on the kind of radiators used. In gravity systems it is suggested "that they be based on 175% of the designed condensation load under standard conditions and a ratio of 0.15 cu. ft. of air per pound of condensate."

[*Title: "Condensate and Air Return in Steam Heating Systems," by F. C. Houghten and J. L. Blackshaw; A.S.H.V.E. paper, annual meeting,* 1933; *approximately* 5000 *words, illustrated with graphs,* 2 *tables.*]

News of the Month

Ice Cooling Surveyed in New England Ice Dealers' Meeting

Speaking on "The Future of Air Conditioning with Ice in New England" before the convention of the New England Ice Dealers Association, Springfield, Mass., March 29, L. S. Davis, sales manager, York Ice Machinery Corporation, made recommendations as to the most effective methods for engineering and merchandising ice cooling equipment, and presented an analysis of the market for this kind of cooling.

Mr. Davis mentioned three sources of technical service available to the ice dealer in making recommendations to his customers. These are the air conditioning engineers, whose services can be had at reasonable cost in the larger communities, the technical committee of the association, and third, most practicable in his estimation, the sales engineering service maintained by the equipment manufacturers.

The speaker strongly advocated the installation of year 'round air conditioning apparatus, rather than the cooling equipment alone, although this phase of it is naturally the ice man's primary interest. This must be done to meet competition, according to the speaker.

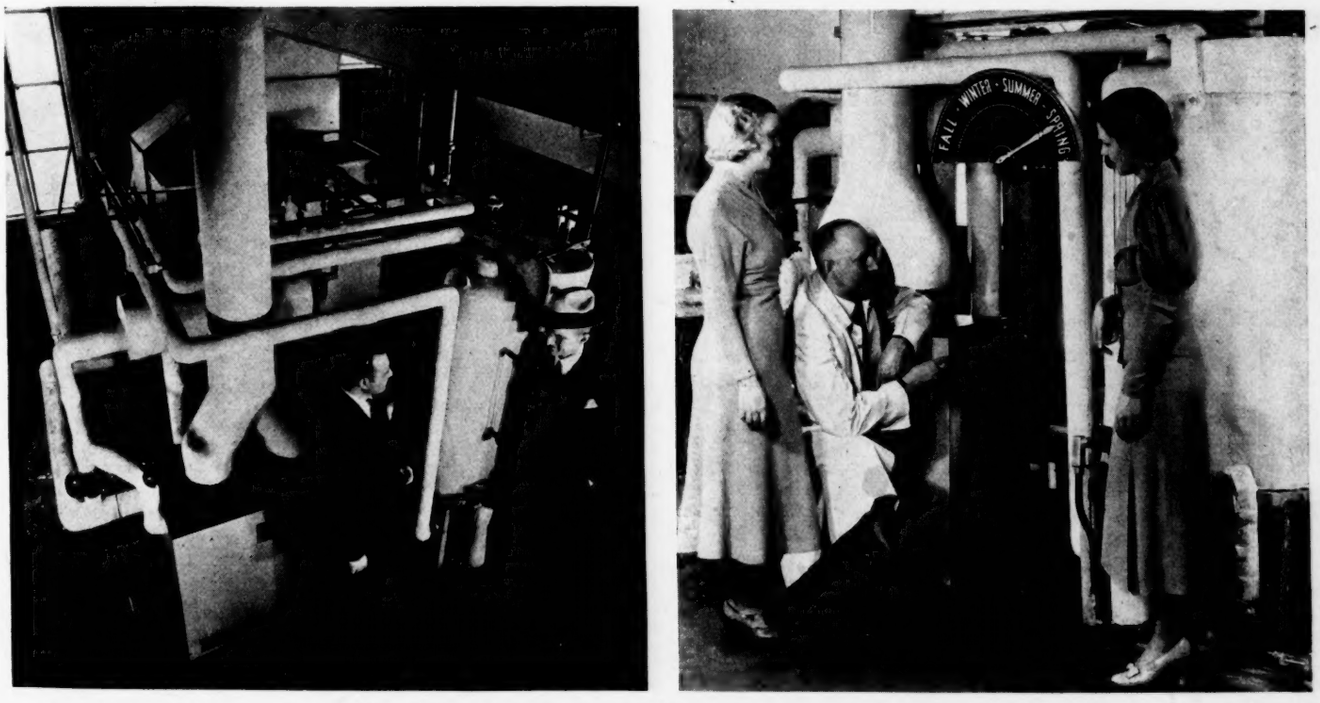
In conclusion, Mr. Davis then summed up the market possibilities for the sale of ice for space cooling in New England, placing the increase in ice tonnage at nearly 13% for residence cooling alone. This increased ice sale should be many times greater when all the commercial possibilities have been exploited.

American Radiator Enters Air Conditioning Field on Large Scale

Announcement by American Radiator & Standard Sanitary Corporation of a line of new air conditioning units, culminating several years of research and engineering activity, was made to the press May 15, preceding the opening of the company's elaborate exhibition at the Century of Progress Exposition in Chicago on May 27. According to Rolland J. Hamilton, president of American Radiator Company, the "Garden of Comfort" erected at the World's Fair was designed to provide a proper setting for the unveiling of the new products.

The principle product announced was an air conditioning unit the basis of which is a steam ejector refrigerating machine. Water is the only refrigerant used, steam being employed to create a vacuum under which the water is reduced at temperatures cool enough to accomplish the desired refrigeration. To be known as the Decalorator, the system is being manufactured in various sizes for homes as well as for the largest buildings. In the plant illustrated, a gas boiler produces the steam for the ejector as well as for heating in the winter. One of these units is furnishing cooled and filtered air in the Home of Artificial Weather at the company's exhibit in Chicago.

In addition, the corporation announced equipment which can be added to furnaces and heating plants now in use so that the old installations can be used for summer cooling as well as winter heat-



Two views of the new line of American Radiator air conditioning equipment. The view to the left shows C. T. Morse, president, (right) and H. E. Barth, sales manager, American Blower Corporation, Detroit subsidiary company, in front of the Decalorator. The view to the right shows the gas boiler, a part of the unit, together with the "Dial of the Seasons" as exhibited in the company's Home of Artificial Weather, one of the buildings in the Garden of Comfort, American Radiator's exhibit at the Chicago World Fair

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ing. Several individual units, resembling in appearance cabinet radiators, were designed to serve the large immediate market, and these were also described by the company officials.

Development of various equipments along different lines has been under way in each of the corporation's subsidiaries. These companies include American Radiator Co., Campbell Metal Window Corp., American Blower Corp., Fox Furnace Co., and the newly-acquired Ross Heater & Mfg. Co. The new products, together with equipment already developed by the company and its affiliates, is said to place American Radiator & Standard Sanitary Corporation in the air conditioning business on a broader scale than any company now in the field.

Live Program for Oil Burner Convention

An interesting program covering merchandising and technical phases of the industry has been arranged for the American Oil Burner Association when it meets in Chicago for its 10th annual convention and show, June 12-16. Headquarters will be located at the Stevens Hotel.

The first two days will be devoted to installation and opening of the show which is being held in Exhibition Hall, and to registration meetings of the board of directors and the various executive committees. Wednesday, June 14, has been designated Dealer Day. The program in part follows:

June 14

9:45 a.m.—A New Dealer's View of the Oil Burner Industry, by L. M. O'Neill, vice-president, Air Conditioning Corporation.
Selling Burner-Boiler Units, by Lionel L. Jacobs, president, Electrol of New Jersey, Incorporated.
Range Burners and Their P'ace in the Oil Burner Industry, by E. W. Pattison, vice-president, The Silent Glow Oil Burner Corporation.
Organization and Profits for the Oil Burner Dealer, by A. K. Perego, president, Perego Corporation.

June 15

9:00 a.m.—Annual meeting.
Meeting of new board of directors.
7:00 p.m.—Annual banquet and dance.

June 16

9:00 a.m.—Engineering Session.
Converting Gas Boilers to Oil, by Prof. L. E. Seeley, Yale University.
The Underwriters' Laboratories — Its Relationship to the Industry, by H. M. Robinson, service engineer, Underwriters' Laboratories.
Installing Heavy Oil-Burning Equipment, by E. L. Maynard, factory engineer, Petroleum Heat and Power Company.
Air Conditioning, by S. R. Lewis, consulting engineer.

Bayley Blower Announces Removal

Bayley Blower Co., Milwaukee, Wis., has moved its office and plant from 1938 South 4th Street to 1817 South 66th Street, West Allis.

The present Bayley Blower Company was organized last November as a reorganization of the old Bayley company. Officers of the company are E. Worthing, president; E. Szekely, vice-president and general manager, and E. Brandt, secretary and treasurer. The directors of the company are the above officers and Walter Drew, attorney.

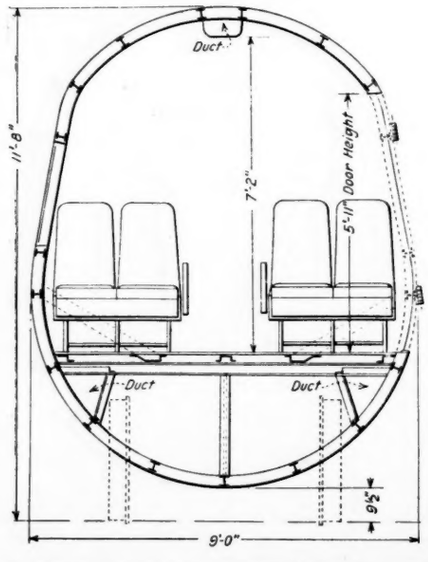
Heating Discussed at Pa. Gas Association Meeting

"Residence Air Conditioning" was the subject of a paper presented by C. H. B. Hotchkiss, editor of HEATING AND VENTILATING, at the 25th annual meeting of the Pennsylvania Gas Association, held at Galen Hall, Wernersville, Pa., May 9-11. The speaker traced the development of the warm-air furnace during the past 10 years of home-heating plants, and showed how different methods of heating have changed relative to each other, particularly in regard to equipment cost and fuel costs. He pointed out that while the total number of oil-burner installations far exceeds those of gas-fired jobs, the rate of increase of the latter is higher.

Hugh Cuthrell, Brooklyn Union Gas Company, spoke on "The Importance of Dealer Cooperation," and Walter Beckford, The Boston Consolidated Gas Company, discussed "Gas Water Heating — The Great Unsold Market."

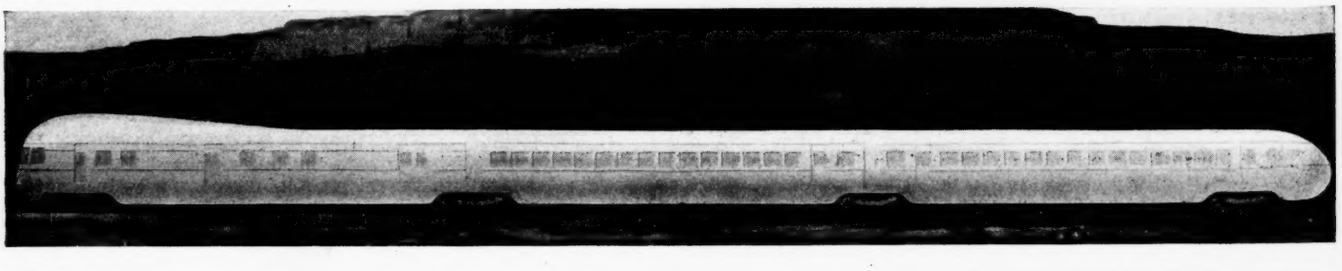
A.O.B.A. Will Back Industry Recovery Act

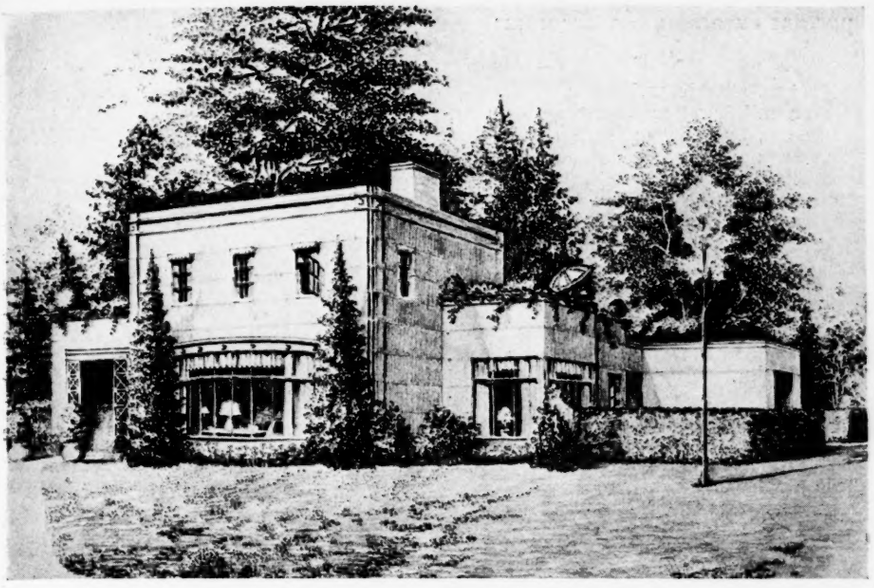
Pledging the cooperation of the oil burner industry through its trade association, Morgan J. Hammers, president of the American Oil



HIGH SPEED, ALUMINUM, AIR CONDITIONED TRAIN FOR U.P.

The rendering below shows the Union Pacific light-weight, streamlined, 110 mile-per-hour air conditioned train, contract for the building of which was let May 24 to the Pullman Company. The train will be constructed of aluminum alloy or stainless steel, with a body of tubular shape. The train of three cars will weigh 80 tons, the present weight of one sleeper, will be fully conditioned, including cooling, and have sealed windows. The cars will be articulated, with one truck between two cars. The drawing shows a section through the train, locations of the ductwork being indicated





AIR CONDITIONED HOUSE FOR CHICAGO EXPOSITION

Sponsored by "Good Housekeeping," this fabricated metal house erected at the Century of Progress Exposition at Chicago has a completely automatic Fox Sunbeam air conditioning system located on the first floor

Burner Association, sent the following wire May 22 to President Roosevelt:

"On behalf of the American Oil Burner Association and with keen appreciation of the responsibilities imposed on industry to do its part, I pledge wholehearted cooperation in advancing the constructive provisions of the proposed National Industrial Recovery Act. The part that the association will play in shaping this industry's practices, including wage and employment, will occupy important place in deliberations of the association's 10th national oil burner convention and show to be held in Chicago June 12-16."

April Building Up More Than Usual Seasonal Increase

There was an increase of 21.2% in indicated expenditures for building construction in April, as compared with March, according to the Bureau of Labor Statistics of the U. S. Department of Labor. The 1933 increase of April over March was greater than the increase shown in comparing these two months in any of the three previous years.

Non-residential building showed the largest gain, the increase being 43.4%, while residential building rose 10.6%. There was a gain of 8.3% in alterations and repairs. The various agencies of the United States Government awarded contracts during April for buildings to cost $4.7 million. This is nearly $1.5 million greater than March, but $7 million less than April, 1932.

N. D. H. A. Convention Program Promises Busy Week

A varied program of business and entertainment is offered members of the National District Heating Association at its 24th annual convention, scheduled for Chicago, June 27-30, with headquarters at the Palmer House. Outstanding features are scheduled as follows:

June 27

10:00 a.m.—Addresses of welcome and response; President's address; Reports of executive committees.
2:30 p.m.—Report of Distribution Committee.
Comparisons of Design and Construction Methods for Distribution Systems.
Line Losses and Delivery of Superheated Steam.
Heating Effect of Underground Steam Mains on Surrounding Soil.
Distribution Line Loss and Unaccounted-for Steam.
Comparison of Operating and Maintenance Methods of Distribution Systems.
District Heating Distribution Construction in Washington, D. C.
Report of Meter Committee.
Manufacturer's Round Table.

June 28

8:00 a.m.—Breakfast Session.
Rates and Regulations.
Meters.
9:30 a.m.—Report of Research Committee.
Report of Station Engineering Committee.

June 29

8:00 a.m.—Distribution Committee.
Steam Station Engineering Committee.
9:30 a.m.—Report of Sales Development Committee.
Insurance Rates Committee.

June 30

10:00 a.m.—Election of Officers.
Report of Operating Statistics Committee.
Report of Hot Water Committee.
Progress Report of Pure Air Committee of A.S.M.E., by N.D.H.A. representative.
Installation of New Officers.

Arrangements have been made for a number of interesting field trips, and many enjoyable diversions are offered. Entertainment features for women guests have received careful consideration. Members will also be able to attend the Century of Progress Exposition, and should find much to interest them at the Sixth Midwestern Engineering and Power Exposition, to be held during the same week, and in participation in the celebration of Engineering Week.

Petro Opens Baltimore Office

The Petroleum Heat and Power Co., Stamford, Conn., has opened a factory branch office in Baltimore under the direction of H. Fenimore Baker. Equipment sales activity will be directed by A. P. Brown, Jr.

American Radiator Acquires Ross Heater

American Radiator Co., New York, announces the acquisition of the Ross Heater & Mfg. Co., Inc., manufacturers of steam ejector refrigeration, heat exchange equipment, and mechanical equipment used in the petroleum industry. The company will operate in the future as a division of American Radiator.

York Ice Machinery Forms Commercial Division

York Ice Machinery Corp., York, Pa., has formed a commercial division to market new commercial refrigeration and air conditioning units through distributors, dealers, and wholesale outlets. This division will promote and develop sales of the company's freon refrigerating compressors for use in commercial refrigeration and air conditioning.

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A group of 10 executives of the company will direct the activities of the new division. C. A. Pearson has been appointed manager of the commercial division, under S. E. Lauer, general sales manager of the corporation.

In each of the 10 branch offices, a supervisor has been appointed in charge of the new division. These supervisors in turn will establish dealers in the cities in which the branches are located, and distributors in adjacent territories will be appointed.

N. W. A. H. A. Ready for Mid-Year Convention

Plans have been completed for the National Warm Air Heating Association's mid-year convention, scheduled for Chicago, June 6-8, with headquarters at the Stevens Hotel. Following are the more important events on the program:

June 6

8:30 a.m.—Registration.
Merchandising for Profit in Our Industry, by Clarence A. Olsen.
The Insulation of Buildings, by M. A. Smith.
Report of Code Committee, by Prof. J. D. Hoffman, Purdue University, chairman.
2:00 p.m.—Manufacturers' meeting.

June 7

10:00 a.m.—Report of Research Advisory Committee, by F. G. Sedgwick, chairman.
Resume of Research Work, December 1 to June 1, Prof. A. C. Willard, Prof. A. P. Kratz, and S. Konzo, all of University of Illinois.
2:00 p.m.—Open forum.
Registers and Grilles for Mechanical and Gravity Systems, by J. H. Van Alsburg.
Rackets in Our Industry, by L. R. Taylor.
The Opportunity for Air Conditioning in Replacement Work, by F. E. Mehrings.
Reports of Officers and Committees.

June 8

10.00 a.m.—Conference relative to the adoption of certain standards of definition and performance for various types of air conditioning equipment, R. K. Jones presiding.

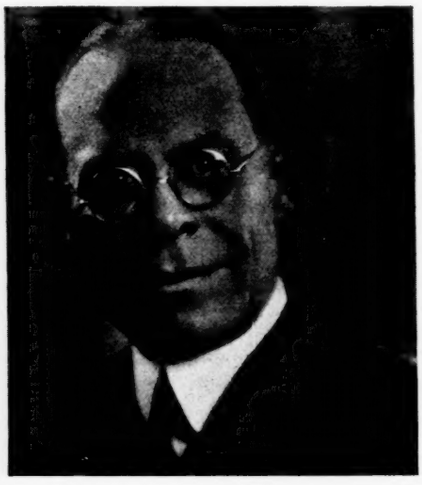
Master Boiler Corp. Formed

A. H. Schroth, for 15 years vice-president, director, and general sales manager of Richmond Radiator Company, has incorporated the Master Boiler Corp., 1440 Broadway, New York. This new corporation, of which Mr. Schroth is president, will market a new boiler and other heating apparatus designed by him and manufactured by the Ideal Furnace Co., Detroit.

Mr. Schroth will also have charge of eastern sales of the Ideal Furnace Company, J. H. Cornell continuing as manager of the New York branch. An office at 1833 Federal Trust Building, Newark, N. J., has recently been opened by Mr. Schroth.

Credit Men to Meet June 20

Credit men from the heating and plumbing group of the Credit Congress of Industry will meet in Milwaukee June 20 at the Hotel Schroeder where the 38th annual



Some of the prominent officials of the National Warm Air Heating Association, which will hold its midsummer meeting June 6-8, in Chicago. Upper left, president, W. L. McGrath, Williamson Heater Company; upper right, first vice-president, H. T. Richardson, Richardson & Boynton Company; above, treasurer and managing director, Allen W. Williams; left, director, F. E. Mehrings, Meyer Furnace Company; right, director, Clarence Olsen, Fox Furnace Company.

meeting of the National Association of Credit Men will be held. The Credit Congress of Industry is the trade group meeting day of the credit men's convention.

The trade groups have scheduled all-day programs built around the broad aspects of sales and credit administration, with special emphasis in each program upon those subjects or problems which are of particular significance to each trade. These meetings have for their purpose the development of cooperation and coordination of effort in sales and credit work, and business executives will derive real and lasting benefit from attendance at the group meeting of their trade associates. Meetings are open to nonmembers as well as to members of the National Association of Credit Men.

Fred J. Blum, of Midwest Piping & Supply Co., St. Louis, is chairman of the Plumbing and Heating Group.

McIlvaine St. Louis Distributor Moves

The Porter Oil Refining Co., St. Louis and St. Louis County distributor for the McIlvaine Burner Corp., Chicago, has recently completed new display rooms and will operate a training school for dealers at 1433-41 Kentucky Avenue.

Investigation Shows Conditioned Air Combats Hay Fever and Asthma

Hay fever and asthma sufferers can find relief by inhabiting pollen-free enclosures, according to a report made May 6 before the Society for the Study of Hay Fever and Asthma, by Dr. Leslie N. Gay, who has been conducting investigations into this subject during the past year at Johns-Hopkins University. It was found that patients afflicted with these conditions were given complete relief within a short time after they had entered a carefully air-conditioned room to which cooled, washed and filtered air was supplied.

It was found that the hay fever victims were relieved more rapidly than were those suffering from hay fever complicated with asthma. Relief, it was reported, depended primarily upon the cleanliness of the air, the temperature and other factors having little effect. Patients generally showed symptoms of the malady upon leaving the air-conditioned chamber for the pollen-polluted outside air, but lost them almost immediately upon reentering the room. Patients afflicted with bacterial asthma did not respond to this treatment.

Arnold New Manager for Petro in Boston and Providence

Glenn Arnold, vice-president of Petroleum Heat and Power Co., Stamford, Conn., is now general manager of the company's Boston and Providence branches. He will also supervise the sale of equipment in these territories.

Illinois Engineers Hear Talk on New Housing

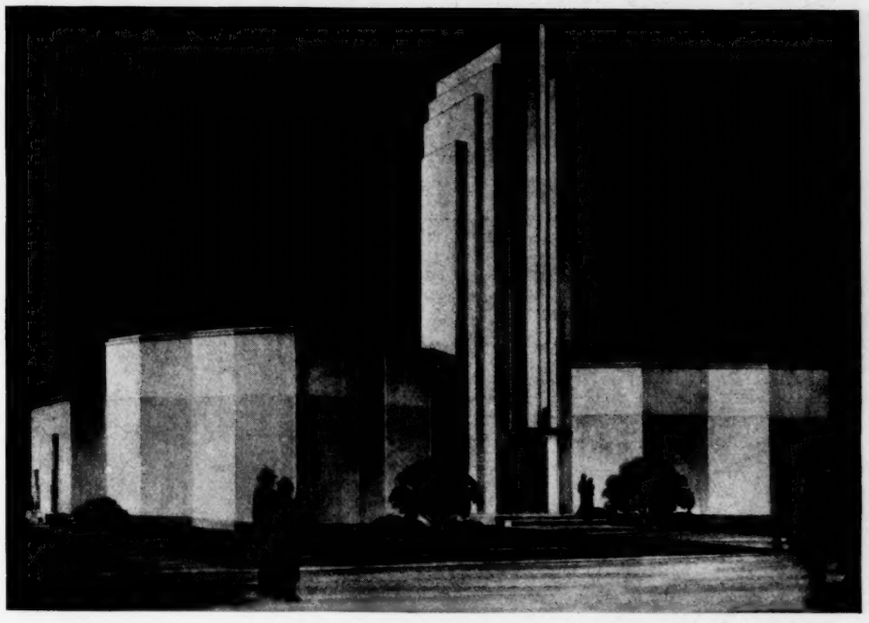
Bennett Chapple, vice-president, American Rolling Mills Company, addressed the Illinois Chapter, A.S.H.V.E., at its final meeting of the season, May 8, at the Hotel Sherman, Chicago, on the subject, "Tomorrow's Home." Mr. Chapple described the steel house erected by his company at A Century of Progress Exposition, and expressed a belief that air conditioning with panel heating would be logical developments in these houses.

A. R. Herske, manager of sales promotion, American Radiator Company, followed with a talk, "Profits in the Contracting Business," in which he stressed the importance of modernization work. Fifty-four members and guests attended.

Orderly Basements Stressed by Bryant

One of the featured exhibits in Home Planning Hall, at A Century of Progress exposition, in Chicago, is a modern basement showing the Bryant Dualator, designed by the Bryant Heater & Mfg. Co., Cleveland. This exhibit has as its object the presentation of proof that a basement can be maintained as orderly and clean as a modern tiled kitchen.

Mops, pails, brooms, and all the other paraphernalia of the ordinary basement are concealed behind panels. In their place are lounging chairs and a table; evidence that a



A HOUSE OF GLASS

Glass bricks, vari-colored in shades of red, orange, yellow, green, and blue, glass-wool insulation on the roof, and glass-wool filters for the air conditioning system go to make up this structure erected at The Century of Progress Exposition by the Owens-Illinois Glass Company. Walls are placed at angles which reflect the colors to the best advantage. The glass blocks have hollow air-tight centers which act as insulators.

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basement can serve the double purpose of housing a heating unit and living quarters at the same time. Pipes, ducts, washing machine, laundry tubs, water heater, fuse box, meters, etc., are all concealed.

Michigan Group Elects Officers

Approximately 50 members and guests of the Michigan Chapter, A.S.H.V.E., participated in a golf tournament preceding a dinner and meeting at the Meadowbrook Country Club, Detroit, May 10. Details of the program for the society's summer meeting were discussed and chapter officers for the ensuing year were elected as follows: president, H. E. Paetz; vice-president, G. S. Winans; secretary, Tom Brown; treasurer, T. K. Milward. A. C. Wallich, Edward Glanz, and John Kilner will comprise the new board of governors.

Distillate Burners off 59% from '32

Shipments of distillate oil burners, used in ranges, water heaters, and stoves, for March, 1933, totaled 3,597, as compared with 10,915 in the same month in 1932, a decrease of 67%, according to the Department of Commerce. The decrease for the first three months of 1933 from the same period last year is 59%.

Chicago Oil Burner Ass'n to Hold Golf Tournament

The Chicago Oil Burner Association, Inc., will hold its seventh annual golf tournament on June 15, 1933. This tournament is being held at the same time the American Oil Burner Association will meet in that city for its tenth annual oil burner show.

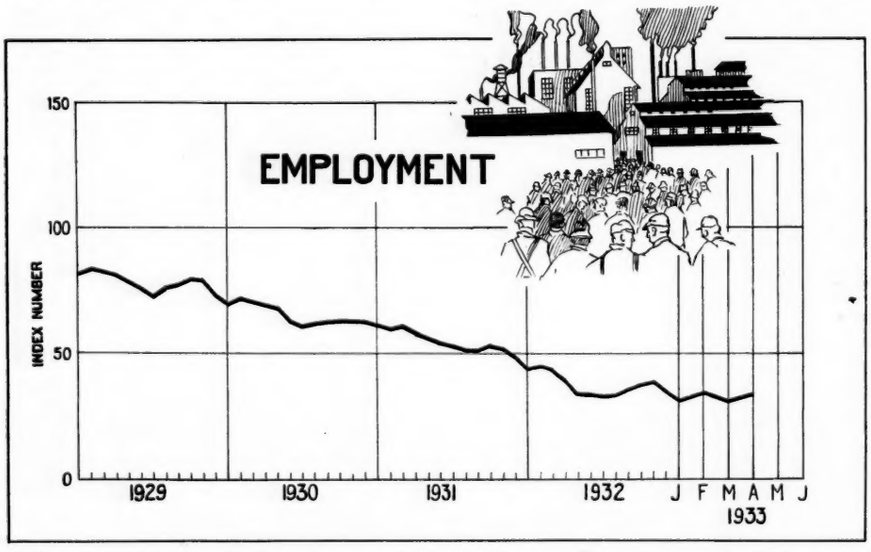
Reservations for the tournament may be made at the oil burner show. The fee will be $3, including green fee and steak dinner. Prizes will be distributed.

Philadelphia Anthracite Bureaus Move to Primos

Philadelphia offices of the Anthracite Institute, Anthracite Service, and Anthracite Bureau of Information, have moved from that city to Primos, Delaware County, Pa., in the building now occupied by the Anthracite Institute Laboratory.

Convection-Type Radiators Take 8% of Radiator Market

Figures for 1932 and the first two months of 1933, recently released by the Department of Commerce, show that convection-type radiators account for 8% of the total radiator market, the remaining 92% consisting of the cast-iron type. Shipments of the cast-iron radiators for the 14-month period amounted to 48,980,000 sq. ft., while new orders received for the convection type totaled 4,300,000 sq. ft. Of the latter, 1,166,000 sq. ft. were for heating elements only, and 3,134,000 sq. ft. were for cabinet and concealed type, including the casings.



EMPLOYMENT IN STEAM AND HOT WATER HEATING APPARATUS AND STEAM-FITTINGS MANUFACTURING PLANTS

The index of employment in the plants of this industry (above) rose from 30.5 for March to 34.0 for April (1926 = 100), and payroll totals increased from 16.0 to 18.0. In the building trades, there was an increase of 8.0% during the same period.

New McIlvaine Distributor in North Shore District

McIlvaine Burner Corp., 663 West Washington Blvd., Chicago, has appointed the Huff Radiaheat Boiler Sales Corp., 749 Custer Ave., Evanston, Ill., as its distributor for Evanston, Wilmette, Winnetka, Lake Forest, and adjacent territory.

New Dealers for Petro Announced

The following dealers were recently appointed by Petroleum Heat and Power Co., Stamford, Conn., to handle the company's oil burners in their respective territories: William H. Cone, 439 Main St., Bennington, Vt.; Henry F. Miller, Crawfordsville, Ind.; A. J. Schmidt & Son, 318 Fifth St., Logansport, Ind.; Caley Hardware Co., Princeton, Minn.; Pipkorn Fuel & Supply Co., Oshkosh, Wis.; R. F. Calloway, 1815 South LaFontaine, Kokomo, Ind.; City Electric Co., 113 North Warren St., Saginaw, Mich.; A. E. O'Toole Co., Inc., 862 Main St., Brockton, Mass.; Pharo Heating Co., Madison, Wis.

Third Heating and Ventilating Exposition to be Held in New York

The Third International Heating and Ventilating Exposition will be held in Grand Central Palace, New York, February 5-9, 1934, according to an announcement made May 31.

The exposition will be in charge of the International Exposition Company, Grand Central Palace, New York, and under the direction of Charles F. Roth, who was re-

sponsible for the earlier shows in Philadelphia and Cleveland. The cooperating committee is composed of C. V. Haynes, chairman, A. A. Ahlff, A. S. Armagnac, A. L. Baum, W. H. Carrier, J. G. Eadie, P. E. Fansler, H. W. Fiedler, J. C. Fitts, Otto Goldschmidt, C. H. B. Hotchkiss, A. J. Nesbitt, A. J. Offner, W. J. Olvany, W. J. Osborn, G. E. Otis, Clyde R. Place, C. H. Quirk, E. C. Rack, H. T. Richardson, E. J. Ritchie, P. H. Schoepflin, N. T. Sellman, B. E. Tiltz, Warren Webster, Jr., and H. S. Wheller.

Frick Company Moves Pittsburgh Office

Frick Co., Waynesboro, Pa., has moved its Pittsburgh office to 401-402 McKay Building, 1005 Liberty Avenue, with Otto C. Arens in charge.

Clarage Appoints Detroit Representative

Clarage Fan Co., Kalamazoo, Mich., has appointed Kilmer-Mills, Stormfeldt-Lovely Building, Detroit, as its representative in that vicinity.

NEW CATALOGS

A. M. Byers Co., Clark Bldg., Pittsburgh, Pa., has issued a booklet, "The New Story of Ancient Wrought Iron," in which modern production methods of the old art of iron refinement are described. Illustrated with photographs of processes. Fourteen pages, 5½ in. by 8 in.

Gorton Heating Corp., Cranford, N. J., has issued its trade price sheet No. 33, covering appliances for the Gorton single pipe vapor heating system and the Gorton Surevent equalizing valve.

Hoffman Specialty Co., Inc., Waterbury, Conn., have issued Catalog V.V.333 describing valves for one and two-pipe steam systems, and one-pipe vacuum and air line systems. Construction and operation is explained; standard size, 11 pages.

Hydro-Ash Corp., 115 South Dearborn St., Chicago, has issued a catalog describing hydraulic ash handling equipment. Various methods of disposal are illustrated; standard size, 14 pages.

Jefferson Electric Co., Bellwood, Ill., has issued catalog leaflet 35-IT, describing its line of transformers for oil burner ignition. Dimensions and electrical specifications are listed. Four pages, standard size.

The Linde Air Products Co., 30 East 42nd St., New York, has issued a booklet, "How To Figure Oxwelding and Cutting Costs," in which methods for determining consumption and costs of material for welding, cutting, and heating operations are summarized. Three general methods are proposed. The first, for large operations, simply takes account of the number of cylinders and fractions thereof consumed on the job. The second outlines a method for accurately determining the quantity of gas remaining in a cylinder at the completion of an operation, including temperature-volume correction. The third method standardizes the quantity of gas used by various types of equipment per unit of time, the time it is in use being the indication of the amount used. A price card for conveniently figuring unit costs is suggested. Standard size, 8 pages.

Mason Regulator Co., 1190 Adams St., Dorchester Center, Boston, has issued Bulletin 3000-c, describing Masoneilan compensated temperature control instruments. Construction is explained and illustrated, and operating characteristics are described; standard size, 31 pages.

Republic Steel Corp., Youngstown, Ohio, has issued a folder containing physical and engineering properties of Toncan copper molybdenum iron; 10 pages, 3½ in. × 6 in.

Steel and Tubes, Inc., 223 East 131st St., Cleveland, has published a "Handbook of Electric Weld Tubing," describing the manufacture and utilization of this product. Physical and engineering properties are listed. Sixty-eight pages, 5 in. × 6¾ in. "The Welding of Enduro Stainless Alloys" is also available from the same manufacturer. Standard size, 17 pages.

25 Years Ago in

The Heating Ventilating Magazine

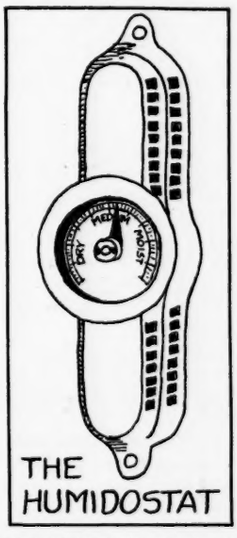
JUNE, 1908

BUILDING OPERATIONS during April, with the exception of some southern cities, continued to reflect the depression in business which has existed throughout the past winter. The figures, however, showed a tendency toward normal conditions in the middle west, several cities in that section reporting increases over last year's operations for the same period. In the eastern cities the decrease was 33%; middle west, 1%; southern, increase, 20%; Pacific Coast, decrease, 51%.

AMERICAN BLOWER CO., Detroit, has taken over the foundry of the Northwestern Foundry & Supply Company, in that city.

CHICAGO, ILL. The new 12-story million-dollar building to be erected at Monroe and Franklin Streets, for Hart, Schaffner & Marx, clothing manufacturers, will be made dustproof and will be equipped with an up-to-date ventilating system, including apparatus for washing and purifying the air. A refrigerating system will be used to cool the air in summer and sterilize and cool the drinking water. Holabird & Roche are the architects.

ATLAS HEATING AND VENTILATING CO., San Francisco, Cal., has been incorporated for $10,000. W. G. Sadler, L. B. Sadler, R. N. Osborn, H. F. Bryant, and J. V. Chase, are listed as the incorporators.



JOHNSON SERVICE CO., Milwaukee, advertises The Humidostat, "a device which reguluates air moisture in a room and holds it to any desired degree." It is the invention of Prof. Warren S. Johnson.

SOUTH BEND, IND. Property owners in the square between Main and Mill Streets, and bounded by Second and Third Streets, are planning to form a central station heating company to heat the business and residential buildings within that square.

News of the Month

Correspondence

Reader Comments on Moisture from Gas Heater

[The following additional comment has been received on Question 73, answered in the "Your Everyday Problems" section in the March issue of HEATING AND VENTILATING, dealing with excessive condensation on the windows of a gas-heated home—ED.]

EDITOR, HEATING AND VENTILATING:

When this condition occurs it is due to low temperature in the chimney flue, especially if it is an outside chimney. When the gas boiler is turned on in the early morning this cold chimney interferes with the draft, causing condensation from the flue gases, resulting in a back pressure which carries out under the diverter. These hot gases supply the moisture that condenses out on the windows.

If the diverter be removed and an open leg installed on the flue pipe close to the chimney, this will deliver a higher temperature in the flue, and will increase the natural draft. The burner input should also be checked. We have successfully overcome all difficulties of this nature in this way.

JAMES HENNESSEY
Jersey Central Power & Light Co.,
Long Branch, N. J.

Efficiency of Boiler-Burner Units

EDITOR, HEATING AND VENTILATING:

In the April issue of HEATING AND VENTILATING, I have just noticed on page 29, in the box at the bottom of the page, a statement to the effect that the question of increased operating efficiency is not thoroughly settled for boiler-burner units.

Without quoting from a mass of test data that is available, it seems to me a little thought would indicate the improved operating efficiency of the boiler-burner unit, over and above the conversion burner unit.

With all due credit to certain reliable and efficient coal-burning boilers now on the market, it is a generally recognized fact that a great many inferior and cheap boilers are sold, exploited by manufacturers who are interested only in low cost.

Most of these inferior boilers are lacking in heating surface. The installation of a conversion oil burner in such a boiler is bound to result in a low operating efficiency. In almost every case a smaller percentage of the heat transfer occurs in the combustion chamber with the conversion oil burner than with the coal combustion, for which the boiler was designed.

Following on, the lack of secondary heating surface which is so necessary to efficient operation with oil combustion, further contributes to the high flue gas temperatures invariably found on such conversion installations.

Also, with a conversion burner, each installation presents an individual problem in itself, concerning effective combustion chamber arrangement. Thus, efficient combustion is out of the hands of the conversion burner designer and is dependent to a large extent upon the skill and technique of a widely scattered installation organization. Therefore, a substantial amount of excess air is often required on conversion installations in order to produce complete combustion. Excessive air, of course, means a reduction in over-all efficiency.

Still further, it is very difficult to secure an air-tight combustion chamber on most conversion burner installations, due to warping of boiler doors and to improper boiler setting. This condition contributes further to excessive combustion air.

I grant that it is possible to use special oil-burning boilers which can be made to approach the over-all efficiency obtained with a coordinated design of boiler-burner unit. Even with these special boilers, we believe it is difficult to obtain certain other important features of control, cleanliness, and appearance, which features can be readily built into the boiler-burner unit. The installations of special oil-burning boilers with conversion burners are at present in the minority.

In conclusion, we believe it is recognized by those skilled in the art of domestic oil heating, that the average over-all efficiency of all boiler-burner units installed is bound to be appreciably higher than the average over-all efficiency of the conversion burner units installed, for the reasons indicated briefly above. We come to this conclusion with due regard for the excellent work which has been done by a number of the outstanding conversion burner manufacturers.

ELLIOTT D. HARRINGTON
Engineer, Air Conditioning Dept.,
General Electric Co.,
New York, N. Y.

COMING EVENTS

JUNE 6-8, 1933. National Warm Air Heating Association Convention, to be held in Chicago, Ill. Headquarters at the Stevens Hotel.

JUNE 12-17, 1933. Tenth Annual Convention of the American Oil Burner Association, to be held in Chicago. Headquarters at the Hotel Stevens.

JUNE 19-22, 1933. Twenty-Sixth Annual Convention of the National Association of Building Owners and Managers, to be held in Pittsburgh. Headquarters at the William Penn Hotel.

JUNE 19-22, 1933. Fifty-First Annual Convention and Exposition of the National Association of Master Plumbers, to be held in New Orleans, La.

JUNE 22-24, 1933. Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers, to be held in Detroit. Headquarters at the Hotel Statler.

JUNE 26-28, 1933. Twentieth Spring Meeting of the American Society of Refrigerating Engineers, to be held in Chicago. Headquarters at the Hotel Sherman.

JUNE 27-29, 1933. Sixth Midwest Engineering and Power Exposition, to be held in Chicago. Headquarters at the Hotel Stevens.

JUNE 27-30, 1933. Twenty-Fourth Annual Convention of the National District Heating Association, to be held in Chicago. Headquarters at the Palmer House.

JULY 25-28, 1933. Annual Convention of the Heating and Piping Contractors National Association, to be held in Chicago. Headquarters at the Hotel Sherman.

SEPTEMBER 25-29, 1933. Fifteenth Annual Convention of the American Gas Association, to be held in Chicago.

FEBRUARY 5-9, 1934. Third International Heating and Ventilating Exposition, to be held in the Grand Central Palace, New York.

New Equipment

Johnson Announces Boiler-Burner Unit

S. T. Johnson Co., 940-950 Arlington Ave., Oakland, Cal., has announced the Oil Heat Servant, consisting of a boiler for steam or hot water heating, combined with a domestic water heating unit, fired by a Johnson spinner-type oil burner. The boiler is rated at 150,000 B.t.u. output per hour, and the submerged copper coil supplies hot water to the faucets at the rate of 6 g.p.m. No hot water storage tank is needed.

Burner operates on No. 3 furnace oil. Ignition is electrical.

Reif-Rexoil Announces Junior Burner

A junior model pressure atomizing oil burner, to be known as Type H, has been announced by Reif-Rexoil, Inc., 37-41 Carroll St., Buffalo, N. Y. It has capacity to handle 1200 sq. ft. of steam radiating surface, is designed to burn No. 3 fuel oil, and has electric ignition. Among the mechanical features listed are a cast air receiver incorporating a silencer, an improved system of air diffusion, and rubber mounting. The burner will include as standard equipment the Penn Electric Switch Company control system.

Reversed Refrigerating Cycle Used in New De La Vergne Air Conditioner

The first commercial application of the much-discussed heat pump, first proposed by Lord Kelvin, by means of which buildings can be heated as well as cooled with a refrigerating machine, has been developed by Baldwin Southwark Corporation, and is being distributed through The De La Vergne Engine Co., Philadelphia. The unit has an additional unusual feature in that no external piping is required for the disposal of water condensed from the air, the condensate being eliminated through a duct to the outside air.

The drawing shows the schematic arrangement of the unit, which is of direct room type. As shown, the unit is being used for cooling. By moving a lever, the refrigeration cycle is reversed and the evaporator becomes the condenser, and the condenser the evaporator. By means of this arrangement, when operating in the winter, more heat is extracted from the air than is put into the system in the form of electrical energy. It is this feature which makes electric heating commercially available.

The compressor is a two-cylinder opposed vertical shaft unit direct-connected to a 2-hp. vertical motor, totally enclosed in the machine. The compressor has a bore of 1¾ in. and a stroke of 1½ in., with a refrigerating capacity of 1½ tons, or 18,000 B.t.u. per hr. The motor operates at a synchronous speed of 1800 r.p.m. Two fans are used direct-connected to a ¼-hp. motor. Freon is the refrigerant.

Bearings of the fan motor are self-oiling of the wick type, requiring attention no oftener than once a year. No other parts need be lubricated since the motor compressor oiling system is so arranged that oil will not be lost or enter the wrong part of the system. The unit is equipped with automatic control. Current characteristics are 220 volts a.c., 1½-2½ kw., depending on outside temperature.

The unit is an entirely self-contained cabinet type, requiring no water connections, drains, or refrigerant piping. The only installation requirements are a duct passing over the window-sill under the raised sash, and connections to a source of electric power. It is usually installed directly in front of a window. It is available in several designs in metal or wood to harmonize with the finish of the room. The approximate size is 56 in. long, 22 in. wide, and 43 in. high.

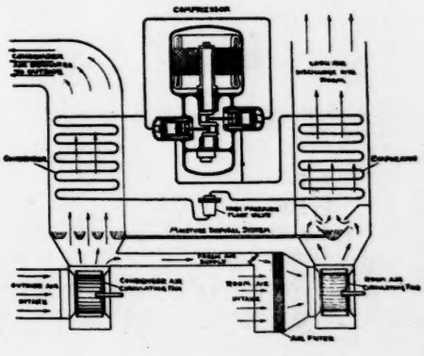
When used for cooling, the unit recirculates the room air together with some outside air, which is introduced under pressure from the discharge duct of the outside air fan. The moisture condensed from the air as it is cooled is collected in a deep pan and drained to a similar pan under the condenser where it is evaporated and carried out of the window with the air in the form of vapor. While passing through the unit the air is filtered.

When used for heating, the unit circulates the air in the same manner, except that the refrigerating cycle is reversed. Heat and moisture in this case are extracted from the outside air and are added to the room, raising its temperature and humidity. The unit is mounted on live rubber to eliminate vibration.

Circulation is at the rate of 600 c.f.m. at all times. When the temperature and humidity need no correction, however, the compressor can be switched off leaving the cir-

(Left) De La Vergne conditioner

(Below) Diagram of system as operated for comfort cooling



culation fan to function as a ventilator and filter.

One unit in a room of approximately 5000 cu. ft. is capable of effecting a reduction of temperature of from 10° to 15°.

A. G. P. Adds New Storage Heater

As a supplement to its line of water heaters, American Gas Products Corp., division of American Radiator Co., 40 West 40th St., New York, has added the Dictator gas-fired automatic storage water heater.

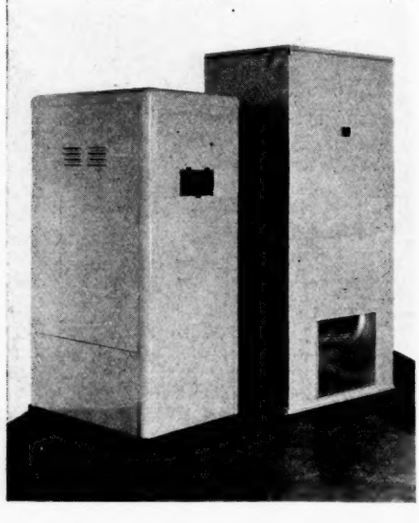
Features mentioned by the manufacturer include rock wool insulation on sides and top, high luster baked enamel jacket, snap action thermostat, and bimetallic thermostatic pilot. A heavy galvanized tank is used. The water heater is made in 15, 20, 30, and 40 gal. sizes.

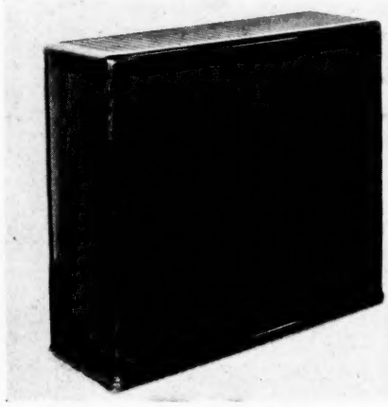
Scott-Newcomb Enters Air Conditioning Field

Scott-Newcomb, Inc., St. Louis, manufacturer of the Pioneer oil burner, has entered the air conditioning field with the announcement of a complete central forced-air plant comprising a boiler-burner unit, blower, and cooling unit and a self-contained mechanical room cooler.

Humidified warm air is supplied by the central plant during the heating season, and the same apparatus circulates cooled, cleaned, and dehumidified air during the summer. The absorption refrigeration principle is applied to the cooling, heat from the boiler-burner unit being utilized to operate the system. Exceptionally low operating cost is claimed by the manufacturer.

The room cooler operates from the lighting circuit and is portable. It is unusually compact, and attractively finished in natural wood finish.





(Left) Scott-Newcomb forced-air plant. (Above) Room cooler

Thermometer Tells Temperature at Remote Stations

A device which detects temperatures at remote points and indicates them at a central point, has been developed by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. This device, called the Electrotemp, is recommended by the manufacturer for application in heating and air conditioning systems, as the temperature in any part of a building or plant can be checked from a central point and the heat distribution controlled accordingly.

Search coils, consisting of copper wire embedded in a metal plate and fitted with a metal cover, are mounted in the various rooms or sections for which temperature readings are desired. These are connected with bell wire leads to the temperature indicator. The conductance of the copper of the search coils, as influenced by the temperature, is an indication of the temperature prevailing at that point, and this is recorded on the Electrotemp which is calibrated to read in degrees Fahrenheit. A dial permits

Electric thermometer for remote temperature readings

switching the instrument to any one of the several extensions. Operating current is supplied by any convenient service outlet.

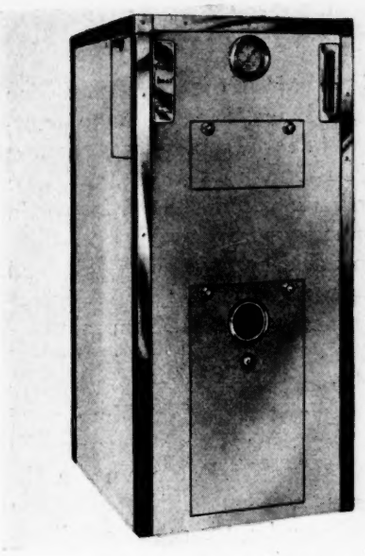
An electric steam generator in sizes ranging from 2 kw. to 240 kw. rating, for supplying steam at either 100 lb. or 200 lb. per sq. in., has been announced by the same manufacturer, who lists among its uses the warming of large homes during the seasons of light heating load.

New Boiler-Burner Combination

Anchor Post Fence Co., Baltimore, Md., has announced the Ideal Fluid Heat boiler-burner unit. The boiler is a product of American Radiator Company.

Burner is a standard Fluid Heat wall flame rotary, which can be set to handle a maximum capacity of 10 lb. of No. 2 oil per hour. The boiler base is shipped with the burner and hearth installed. Electric ignition is standard, but gas ignition may be provided. Low water cut-off is included as standard equipment, but a combined low water cut-off and automatic feed is available. Air enters through a grille at the lower rear, and oil line and electric wiring enter the casing at the rear floor line.

Boiler is of the cast iron vertical type having oval sections with ground joints. Combustion gases strike the crown and are diverted around a skirt before entering the



Ideal Fluid Heat unit

heat transfer passes. A green enameled jacket with chromium corner angles and trim, and lined with air cell asbestos, encases the unit. Adequate clean-out doors are provided, and a large door at the front gives access to the burner. Rated capacity is 800 sq. ft. of direct steam radiators.

Apparatus for Supplying and Measuring Humidities Described

Apparatus for producing an atmosphere of known humidity with a fine degree of accuracy is described in the February issue of *Bell Laboratories Record* by A. C. Walker, telephone apparatus development engineer, Bell Telephone Laboratories, Inc., New York. The apparatus is used in the laboratory for the calibration of a continuous humidity recorder of high sensitivity, described in the April issue of the same publication, and also for the study of the properties of various insulations under different atmospheric conditions.

Briefly, the device provides two streams of air, one of which is thoroughly dried, and the other nearly saturated with water vapor at constant temperature. These streams of air are then mixed in accurately controlled proportions, by regulating the relative pressure differentials which drive the dry and the moist steams past the mixing point. The air as delivered from the apparatus has a known constant absolute humidity, and the temperature at which it is used determines its relative humidity.

The apparatus for measuring and recording low humidities, described in the April issue, operates on the wheatstone bridge principle. Arms of the bridge are enclosed in metal cylinders through which the air to be analyzed is passed. The heat conductivity of the air, as determined by its relative humidity, determines the temperature of the wire, of which its resistance is an index.

Self-Contained Room Cooler

Carrier Products Corp., Newark, N. J., is marketing the Carrier self-contained type Weathermaker, a one-ton room cooler for residential, office, and similar installations.

Cooling apparatus is enclosed within the cabinet. The refrigerating machine is mounted in the lower part of the casing, and air circulating fans and the cooling coils are located in the upper portion. The cabinet is of enameled steel, finished in dark walnut, and is 59 in. high, 42 in. wide, and 17 in. deep.

Lewis Develops Low-Voltage Humidity Control

Lewis Air Conditioners, Inc., 829 Second Ave., South, Minneapolis, Minn., has announced the open contact low-voltage Humitrol, for which extraordinary sensitivity is claimed in the control of humidifying and dehumidifying equipment.

A ribbon-type hygroscopic element actuates open iridio-platinum contacts in either two-wire or three-wire systems. The device will carry up to 25 watts at 25 volts, and is suitable for use in conjunction with a transformer relay on larger loads. It can be used without transformer at a load of 2 amperes at 110 volts.

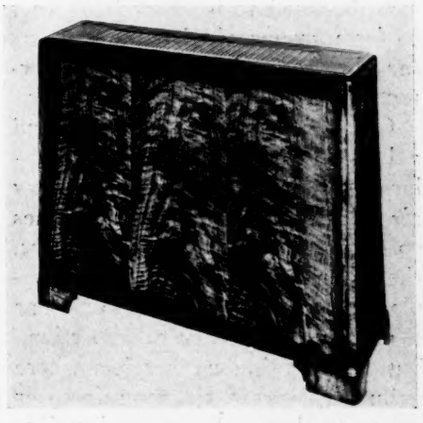
Humitrol is factory-adjusted to maintain any specified relative humidity up to 100% at an operating differential of 1%. The user may adjust this setting up or down 10% by turning the dial indicator. The control is enclosed in a walnut bakelite case of 2⅞ in. width and 7⅞ in. length, projecting 1¾ in. from the wall.

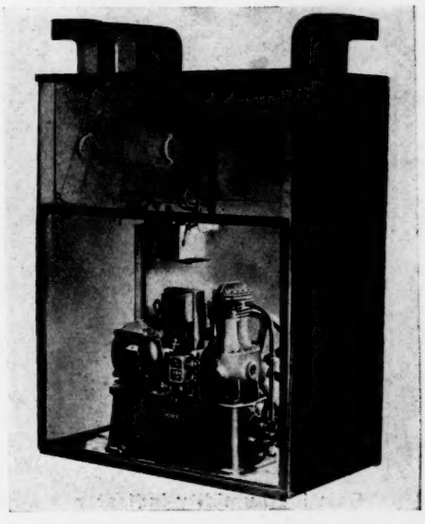
Freon Refrigerant for New Line of Air Conditioners

York Ice Machinery Corp., York, Pa., has announced that newly-developed compressors using freon as the refrigerant are being used with the company's revised line of unit type and central air conditioners.

Individual room units are manufactured in both the floor type and the ceiling type to be used with basement-mounted compressors. Central system conditioners are self-contained units for basement installation. Both systems perform year 'round air conditioning service, steam or hot water being used in the coils during the heating season.

Compressors are manufactured in a range of sizes to meet any cooling requirement. These are motor-driven through a V-belt, and operation is automatically regulated to





(Above) York floor-type unit conditioner. (Right) Central-system type conditioner, showing freon compressor

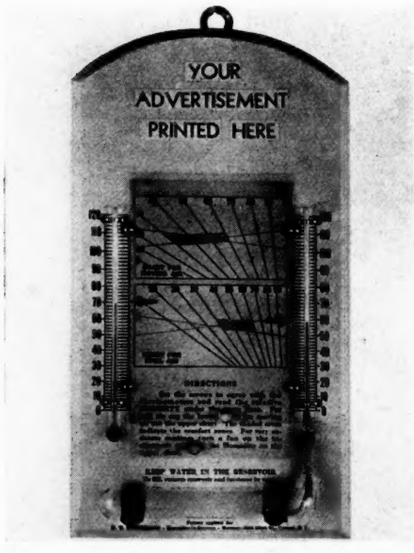
maintain the desired condition. Cylinders are machined from nickel-steel castings developed for this service by the manufacturer. Balanced double trunk-type pistons of the same material provide crosshead effect resulting in even distribution of pressure on cylinder walls. Imported Swedish steel is used in the Pressureflex discharge and exhaust valves of unusual design.

A high-pressure cut-out automatically stops the machine in case of water supply failure and permits resumption of normal operation when cause of high pressure has been corrected. A pressure-actuated refrigerant valve regulates the flow of liquid to evaporator.

Instrument Indicates Relative Humidity

Designed as an advertising novelty for vendors of air conditioning equipment, the Dusinberre humidity indicator, manufactured by the Dusinberre Indicator Co., 3314 106th St., Corona, New York, combines a psychrometric thermometer with a relative humidity calculator.

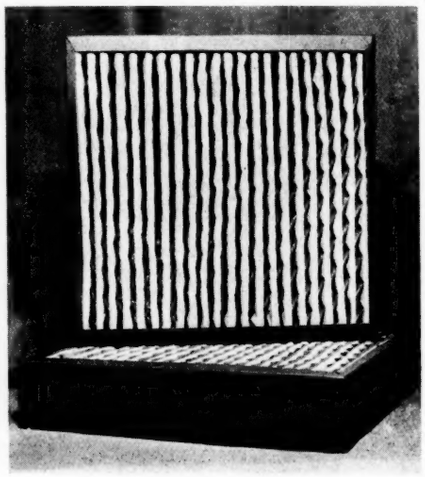
Relative humidity is read directly on the chart at the point of intersection of hair lines traced on transparent slides. These slides are moved up or down to set the arrows on the dry bulb and wet bulb temperatures as indicated on the thermometers. A wick dipped into a water reservoir keeps the wet bulb moist. Two charts are provided, one for still air, and the other for readings when the air is in motion. Shaded areas on the charts indicate the comfort zones.



Relative humidity indicator

Dry Filter Has Low Flow Resistance

Airplex, a dry type air filter for air conditioning, general ventilation uses, warm-air heating systems, and similar applications, has been announced by the Davies Air Filter Co., 390 Fourth Ave., New York.



Davies Airplex filter units

Filter units are made up of 24 sq. ft. of cotton fabric filter medium pleated into a steel frame, the distance between the folds of material being maintained constant by corrugated spacers. This unit fits snugly into a one-piece steel supporting frame having an expanded metal guard at the rear and fitted with a felt seal. These frames are built of 16-gauge steel, properly reinforced, and designed to be bolted together to form groups of whatever number may be required to provide the correct capacity.

Great dust-holding capacity and a long life are claimed, due to the large surface and consequent low air velocity. When the filter becomes so dirty as to impair its usefulness, the units are disposed of and replaced by new ones. Each unit has a maximum capacity of 800 c.f.m., but for continuous service where pollution is great, the manufacturer recommends a 600 c.f.m. rating. Resistance to flow is slightly more than 0.2 in. of water at the 800 c.f.m. rate.

Century Electric Has Splash-Proof Motor

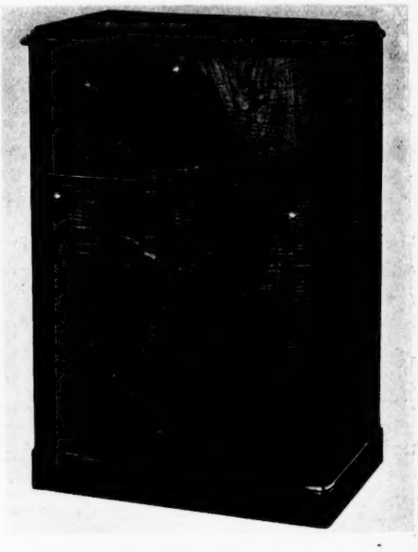
Century Electric Co., 1806 Pine St., St. Louis, Mo., is manufacturing a line of splash-proof motors in sizes from 1 hp. to 30 hp. These motors are recommended for use in locations where drives are subject to splashed or sprayed liquids, and for out-of-door installations where there is no protection from rain.

Baffles cast in the grey iron end brackets prevent entrance of water and solid matter into the interior of the motor. Ventilating air enters the motor through the opening in the lower part of one end bracket, and is discharged at the other end. Bearing bracket is fitted to the gray cast-iron frame by a long contact sealed fit. Cartridge-type, grease-lubricated ball bearings are used on all sizes.

Ilg Announces Mechanical Room Cooler

Ilg Electric Ventilating Co., 2850 North Crawford Ave., Chicago, has announced the Ilg-Spot-Kooler, a self-contained, cabinet-type mechanical room cooling unit.

An Ilg twin compressor, mounted in the lower part of the cabinet, supplies refrigeration to the double cooling coils, and a motor-driven propeller fan circulates and distributes the air. The air is delivered through a circular deflector in the front of the cabinet which permits direction of the stream in any direc-



Ilg-Spot-Kooler

tion—up, down, or sideways—without direct draft.

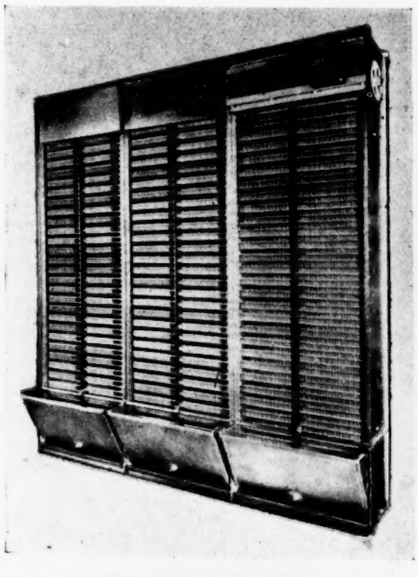
Cooling capacity is 0.55 of a ton, and air delivery is 280 c.f.m. Walnut veneered cabinet is 30 in. wide, 48 in. high, and 18 in. deep. Motor drive is furnished to meet the various power supply specifications. Rubber tubing for connection to water supply, and 25 ft. of flexible electrical connector, are supplied as standard equipment.

Air Filter Fabricated from Aluminum

Air filters of aluminum, products of Independent Air Filter Co., 29 South Clinton St., Chicago, and said to be the first to be made of this material, were recently installed in a Pittsburgh church.

Filter medium consists of an endless curtain made up of overlapping aluminum plates having rasp-like surfaces. This curtain is supported vertically, passing over a shaft which is revolved by a motor to shift the filter at predetermined intervals. The lower portion of the suspended curtain dips into a trough containing oil, which removes dust and replenishes the oil film on the surfaces of the filter.

As the air passes through the medium its direction is abruptly changed six times, and dust and dirt are deposited upon the oil-coated surfaces. The shifting device is ordinarily timed to move the filter curtain a distance of 2 ft. every 24 hr.

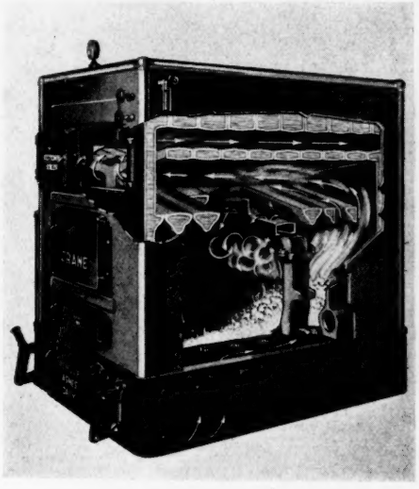


Aluminum air filter

Crane Develops Smokeless Boiler

Crane Co., 836 South Michigan Ave., Chicago, is marketing a cast-iron smokeless boiler for bituminous coals, the feature being an arrangement to supply secondary air. The device consists of two hollow risers and a hollow distributing arch, cast in chrome iron. The risers are held in position by lugs cast into the arch.

Secondary air conducted from the ashpit is preheated in passing through the risers to the distributing arch, combining with the volatile products of the bituminous fuel at the top of the combustion chamber. The attachment may be installed in a heating plant already in service without removing boiler sections or piping, and it is applicable to boilers ranging in output from 96,000 B.t.u. to 1,250,000 B.t.u.



Smokeless combustion arch in Crane boiler

Die Head for Modernizing Pipe Threading Machine

Oster-Williams, Cleveland, Ohio, is marketing the No. 706 die-head. Installed on an old or obsolete machine, this head will afford modern improvements to the equipment.

Pipe sizes from 1 in. to 6 in., and bolts from ¾ in. to 6 in. can be handled by the head, which is calibrated for Briggs standard. A micrometer adjustment for over or undersize threads is standard equipment. Threading dies are of the small segmented type made of high speed steel, five to a set. For pipe work, one set of dies threads all sizes from 1 in. to 2 in. ,and a second handles all sizes from 2½ in. to 6 in. Die holders are moved in or out by the leaf and slot method.

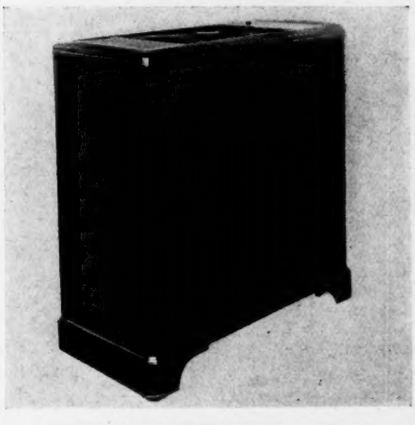
Cutting oil is forced through the head, one stream of oil directed in front of the cutting edge of each die. A single high-speed cutting blade is mounted on a slide, screw-operated, and a forming tool mounted on the cut-off slide performs reaming and chamfering operations.

G. E. Offers Line of Conditioners

General Electric Co., Schenectady, N. Y., is manufacturing a line of summer cooling and year 'round air conditioners, to meet the requirements of a variety of installations. Included are self-contained coolers of the portable, floor, or wall type; room coolers operating from remote compressors, and a complete air conditioning unit for winter and summer operation.

Portable units are mounted on rubber-tired wheels. The cabinet, which encloses complete unit comprising compressor, circulating fan, and heat exchange surface, is 43 in. long, 33 in. high, and 13 in. deep. Electrical connection and rubber hose connection for condensing water are included.

Non-portable room coolers perform the same cooling and dehumidifying functions, but operate with compressor located in the basement or other remote point. A one-ton compressor is provided for the cabinet cooler, and a two-ton compressor is available for operating



Floor-type G-E room cooler

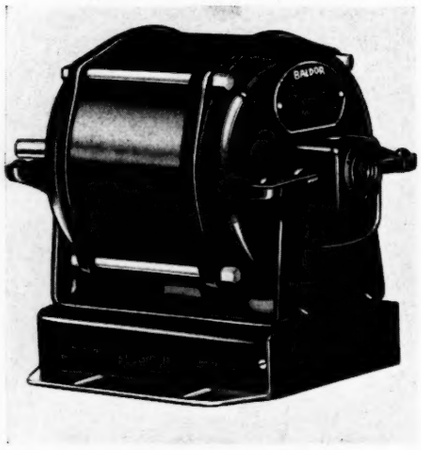
two units. Units may be either floor or wall-mounted.

For all-season air conditioning, this manufacturer is marketing a unit which heats and humidifies in winter, and cools and dehumidifies during the summer, in addition to providing circulation and filtration of air during all seasons. Compressor is mounted within the cabinet, and the capacity is 2/3 of a ton of refrigeration. For heating purposes, the unit will replace 40 sq. ft. of radiator surface. Change-over from summer to winter operation is effected by throwing a switch and adjusting a water valve.

Baldor Improves Fractional Horsepower Motors

Several improvements and innovations are evident in the revised line of fractional horsepower motors for household appliance drive recently announced by the Baldor Electric Co., 4351 Duncan Ave., St. Louis.

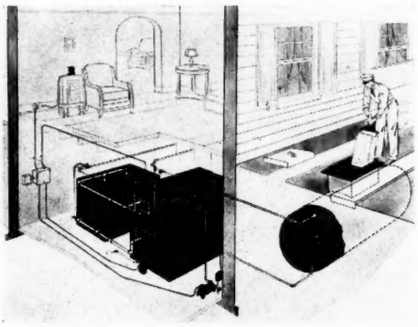
Capacitor motor is spring-mounted over an exceptionally neat and compact base which contains an electrolytic condenser and the terminal box. Rotor is dynamically balanced, and the design is such as to eliminate the high-pitched magnetic hum peculiar to induction motors. Stator frame is of the rolled steel type, and splash-proof end plates support accurately machined phosphor bronze bearings. Both capacitor motors and split-phase motors are available in 1/8, 1/6, and 1/4 hp. ratings for operation at 1725 r.p.m. on 110-volt alternating current. Starting torque of capacitor type is approximately 400% of full load, and that of the split-phase type is about 200% of full load, according to the manufacturer.



Baldor capacitor motor

American Blower Announces All-Year Conditioner

A complete forced-air type indirect system, performing year 'round air conditioning functions, has been announced by the American Blower Corp., Detroit, Mich. The plant consists of a hot water heater connected to an American Blower conditioner unit, and ice-cooled, electrically-refrigerated, or cold tap water is circulated in the coils for summer cooling.



American Blower conditioning system, with ice tank installation

Sirroco fans draw air into the conditioner, pass it through a filter, and circulate it over the copper-finned heat exchange coils before discharging it back into the room. A humidifier is provided. The system is manufactured in four sizes, ranging in capacity from 1200 c.f.m. to 4200 c.f.m.

Hoffman Announces Low-Priced Radiator Trap

Hoffman Specialty Co., Inc., Chrysler Building, New York, has introduced the No. 17-A thermostatic radiator trap, including at a reduced price many of the features incorporated in other traps sold by this manufacturer.

Bellows are 1½ in. in diameter and are hydraulically formed with six convolutions, tested in the making to 500 lb. per sq. in. It is said that with this method of manufacture, the folds of the bellows maintain a uniform metal thickness and are unimpaired by tool marks. The thermostat is attached to the cap and is interchangeable without adjustment.

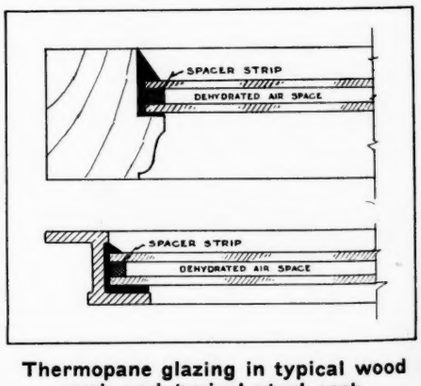
Connections are ½ in. and are available in angle and swivel patterns. The nominal capacity for pressures under 1 lb. per sq. in. is given as 200 sq. ft. of radiation. The maximum operating pressure for which the trap is guaranteed is 15 lb.

Thermopane Double Glazing for Insulation

Charles D. Haven, 2016 East Newton Ave., Milwaukee, Wis., is marketing Thermopane, a manufactured double glazing for windows and door openings instead of single sheet glazing, to provide heat insulation and reduce or prevent condensation and frosting. It may also be used as sound insulation in doors, partitions, etc.

Dehydrated air is sealed by a bonding process between two panes of glass, rendering it air-tight, water-tight, and dustproof. Spacer bars hold the glass a specified distance apart, and it is installed like a single sheet of glass in the sash. When installed, it looks like a light of clear glass.

Thermopane glazing is made with three standard air space thicknesses to meet present sash design. The manufacturer states that the ⅛ in. spacing represents a heat saving of about 40% over single glazing, the ¼ in. about 50%, and the ½ in. about 60%. It is made up with flat glass of any kind, strength, or texture, as desired. It is not carried in stock, but is built to specification to fit any type of sash as required for each order. It cannot be cut on the job.



Thermopane glazing in typical wood sash and typical steel sash

VISIT BOOTHS 3 4 5 AT THE CONVENTION

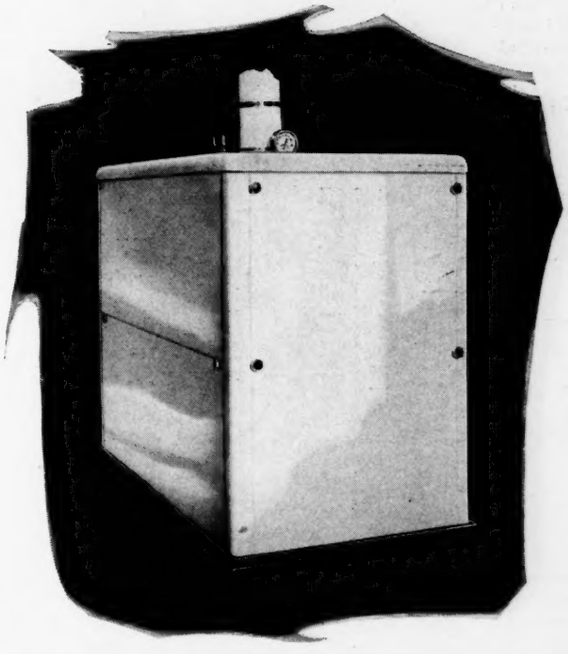
Be sure to look inside the Jacket of the ELECTROL-KEWANEE HEATING UNIT

SEE FOR YOURSELF
WHY IT'S THE LEADER IN THE UNIT FIELD

It's what's *inside the jacket* of a heating unit that counts. Be sure to examine the Electrol-Kewanee Heating Unit at the Oil Burner Show in Chicago. See for yourself its many advantages, such as its horizontal steel boiler, induced draft, long gas travel, intermediate shell construction and many others that make it the one really outstanding unit on the market today.

Whether it's conversion oil burners or boiler-burner units, user satisfaction (and that means dealer profits!) depends on a time-tested, correctly designed product backed by a responsible manufacturer.

You'll find that user satisfaction (and those dealer profits!) with Electrol Oil Burners and Electrol-Kewanee Heating Units. Electrol dealers are making money today. Drop in at the Electrol exhibit and lets talk over the profit possibilities in the Electrol franchise for your territory.



ELECTROL-KEWANEE HEATING UNIT

ELECTROL OIL BURNER

AT THE SHOW—BOOTHS 3-4-5

ELECTROL INCORPORATED
227 EAST 45TH STREET
NEW YORK

ELECTROL

FINE OIL HEATING EQUIPMENT EXCLUSIVELY—SINCE 1918

Degree-Days for Season About Normal, but Above Last Year

(Percentages below indicate increase or decrease in degree-days for this season, Sept. 1 to Apr. 1, compared with normal)

EAST	
New York	—10.4%
Philadelphia	—14.1
Boston	+ 5.8
Buffalo	— 7.7
Baltimore	—11.9
Pittsburgh	— 4.2
MIDDLE WEST	
Chicago	— 3.0%
St. Louis	— 4.4
Kansas City	— 9.9
Minneapolis	+ 0.2
Cincinnati	+ 1.2
Cleveland	—12.1
Detroit	— 5.9
Indianapolis	— 1.7
Louisville	+ 1.2
Des Moines	— 0.6
SOUTH	
New Orleans	+ 6.8%
Atlanta	—2.6
Birmingham	+ 2.5
Memphis	+ 3.6
FAR WEST	
Denver	+ 1.5%
Seattle	—0.5
San Francisco	—0.7
Los Angeles	—8.0

TEMPERATURES for April throughout the country ran close to normal, so that fuel consumption, as reflected by the degree-day figures, should be running close to computed figures for the month. Addition of the monthly figures to the totals for the present heating season brings our figures up to May 1, close to the end of the season. Comparison of these seasonal totals for this season with normal, or average, totals, and with last year's figures, are shown to the left and right, respectively.

For the month of April, San Francisco's total of degree-days was exactly equal to the normal for the month. As compared with last season (1931-32), Seattle's seasonal total this year was close, this year's figure being only 0.5% less than last year. That city's total was also 0.5% less than the normal figure for the season. New Orleans shows a total for the season to May 1 over 66% higher than last year. All of the southern cities are running well above last year, while eastern cities show totals from 3% to 18% above last year. Middle-western cities are somewhat colder than last year, figures for the season ranging from 5% to 24% above the preceding season.

Degree-days for April, together with totals for the season, last season and normal, with fuel consumption data for April, are shown below.

(Percentages below indicate increase or decrease in degree-days for this season, Sept. 1 to Apr. 1, compared with last year)

EAST	
New York	+ 10.4%
Philadelphia	+ 13.2
Boston	+ 3.1
Buffalo	+ 8.3
Baltimore	+ 17.7
Pittsburgh	+ 12.2
MIDDLE WEST	
Chicago	+ 16.5%
St. Louis	+ 23.9
Kansas City	+ 16.0
Minneapolis	+ 13.6
Cincinnati	+ 19.6
Cleveland	+ 5.1
Detroit	+ 13.6
Indianapolis	+ 19.3
Louisville	+ 23.1
Des Moines	+ 13.1
SOUTH	
New Orleans	+ 66.5%
Atlanta	+ 32.4
Birmingham	+ 39.8
Memphis	+ 39.8
FAR WEST	
Denver	+ 5.1%
Seattle	—0.5
San Francisco	—9.1
Los Angeles	—7.7

Degree-Days and Unit Fuel Consumption—April, 1933

	Atlanta	Baltimore	Birmingham	Boston	Buffalo	Chicago	Cincinnati	Cleveland
Degree-days for April, 1933.....	169	311	130	556	604	547	388	464
Degree-days, Sept. 1, '32 to Apr. 30, '33.	2816	3974	2469	5034	5978	5858	4741	5231
Degree-days, Sept. 1, '31 to Apr. 30, '32.	2126	3377	1766	4894	5522	5029	3958	4975
Degree-days, Sept. 1 to April 30, Normal	2891	4510	2408	4758	6474	6040	4683	5954
Lb. coal per sq. ft. rad., April, 1933.....	1.352	2.488	1.040	4.448	4.832	4.376	3.104	3.712
Gal. oil per sq. ft. rad., April, 1933.....	0.116	0.213	0.089	0.381	0.414	0.375	0.266	0.318
Cu. ft. gas per sq. ft. rad., April, 1933...	16.22	29.86	12.48	53.38	57.98	52.51	37.25	44.54

	Denver	Des Moines	Detroit	Indianapolis	Kansas City	Los Angeles	Louisville	Memphis
Degree-days for April, 1933.....	594	444	531	396	312	185	318	144
Degree-days, Sept. 1, '32 to Apr. 30, '33.	5688	6214	5895	5149	4765	1301	4230	3055
Degree-days, Sept. 1, '31 to Apr. 30, '32.	5413	5495	5202	4318	4108	1409	3437	2214
Degree-days, Sept. 1 to April 30, Normal	5606	6254	6268	5239	5287	1414	4180	2950
Lb. coal per sq. ft. rad., April, 1933.....	4.752	3.552	4.248	3.168	2.496	1.480	2.544	1.152
Gal. oil per sq. ft. rad., April, 1933.....	0.407	0.304	0.364	0.272	0.214	0.127	0.218	0.099
Cu. ft. gas per sq. ft. rad., April, 1933...	57.02	42.62	50.98	38.02	29.95	17.76	30.53	13.82

	Minneapolis	New Orleans	New York	Philadelphia	Pittsburgh	St. Louis	San Francisco	Seattle
Degree-days for April, 1933.....	605	18	445	341	409	300	298	468
Degree-days, Sept. 1, '32 to Apr. 30, '33.	7632	1093	4656	4113	4939	4385	2434	4421
Degree-days, Sept. 1, '31 to Apr. 30, '32.	6715	656	4252	3634	4401	3539	2679	4444
Degree-days, Sept. 1 to April 30, Normal	7615	1023	5193	4787	5157	4585	2418	4397
Lb. coal per sq. ft. rad., April, 1933.....	4.840	0.144	3.560	2.728	3.272	2.400	2.384	3.744
Gal. oil per sq. ft. rad., April, 1933.....	0.415	0.012	0.305	0.234	0.280	0.206	0.204	0.321
Cu. ft. gas per sq. ft. rad., April, 1933...	58.08	1.73	42.72	32.74	39.26	28.80	28.61	44.93

Fuel consumption figures given above are based on certain conditions, and for other conditions corrections must be made. The figures assume the use of steam radiators emitting 240 B.t.u. per sq. ft. per hr., a system operating at 100% efficiency, and radiators calculated for maintaining 70° in zero weather. Heating values assumed for the fuels are 12,000 B.t.u. per lb. for coal, 1000 B.t.u. per cu. ft. for gas, and 140,000 B.t.u. per gal. for oil. To correct for other heating values, efficiencies, and design conditions, follow the method explained in the "Heating and Ventilating Degree Day Handbook."

There is Profit for you in the Experience of these men!

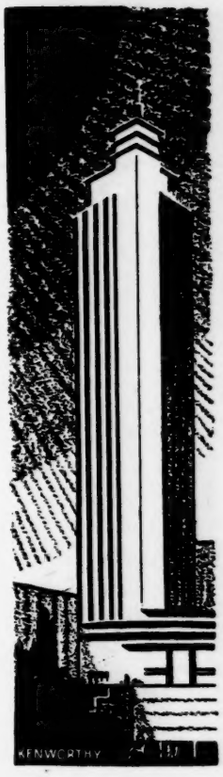
Never before has the experience of successful sales promotion executives meant so much! Never before have the lessons to be learned been so valuable!

The minds that the N.I.A.A. has gathered together for the coming "Industrial Marketing Conference" in connection with Engineers' Week and A Century of Progress have a message of help for YOU. They have a story of proven sales and advertising success during the tragic years of 1931 and 1932.

Look over these names and plan to hear these men!

W. L. Rickard, Pres., Rickard & Co.
A. C. Nielsen, Pres., A. C. Nielsen Co.
Bennett Chapple, Vice-Pres., American Rolling Mills Co.
Donald R. Dohner, Dir. Art, Eng. Dept., Westinghouse Elec. Co.
L. S. Hamaker, Sales Promotion Mgr., Republic Steel Corp.

These are but a few of the many that will discuss advertising, sales promotion, marketing methods and their relation to existing conditions and the future of selling. These men know their subject and have solutions to problems similar to yours. To hear them is to profit!



—And your Special Problems will get Special Attention!

TIE THESE TOGETHER IN ONE BIG WEEK—

National Industrial Advertisers Association Industrial Marketing Conference
Engineering Week
Midwest Power Show
A Century of Progress
Chicago, the Summer Resort

JUNE 26-28

Clinic talks will discuss actual campaigns, reasons why, and objectives desired. There will be booths where subjects dealing with sales presentation, the planning and making of sales manuals, the problem of the house organ, the obtaining and selling of construction leads, translating inquiries into sales, etc., may be discussed at leisure with those that have been studying these subjects for weeks, and are fitted to be a real help to you. An advertising exhibit will treat the campaigns that have run during the year. There you can see what your competitor is doing in its entirety.

Plan now to come! See the Fair—visit the many conventions during Engineering Week—stay for the Midwest Power Show and live at the beautiful Medinah Athletic Club with all its pleasant facilities.

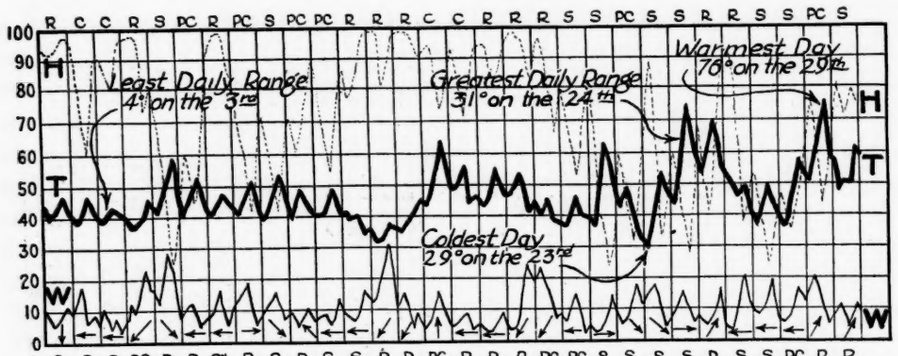
We are in a position to make arrangements to ease your stay for the Fair. Let us help you.

June 26 to 28! We expect you! Write for details.

NATIONAL INDUSTRIAL ADVERTISERS ASSOCIATION
National Headquarters — 537 S. Dearborn St.
CHICAGO

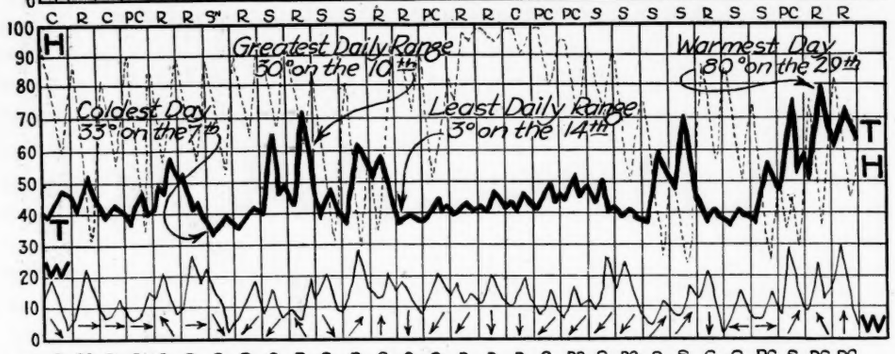
THE WEATHER FOR APRIL, 1933

Plotted from records especially compiled for HEATING AND VENTILATING by the U. S. Weather Bureau. Heavy curves (T), temperatures in deg. F.; dotted lines (H), per cent relative humidity, from readings at 8 a.m., noon, and 8 p.m., except for New York, which shows hourly readings. Light lines (W), wind velocity in m.p.h. Arrows indicate prevailing wind directions. S—clear; PC—partly cloudy; C—cloudy; R—rain; Sn—snow.



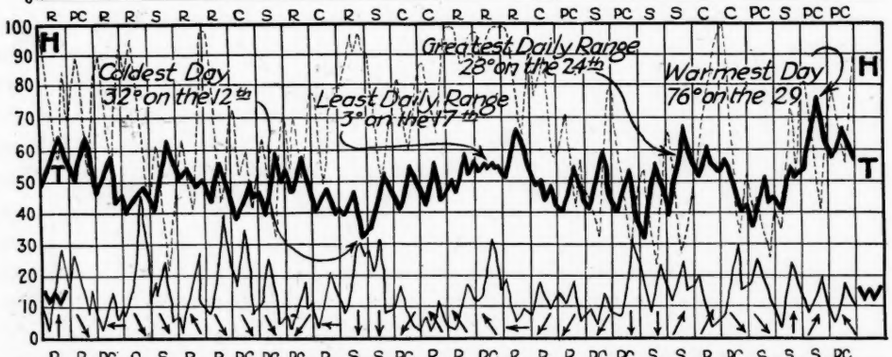
Boston

Mean temp. for month, 46.5°; aver. wind velocity, 9.8 m.p.h.; prevailing direction of wind, E.



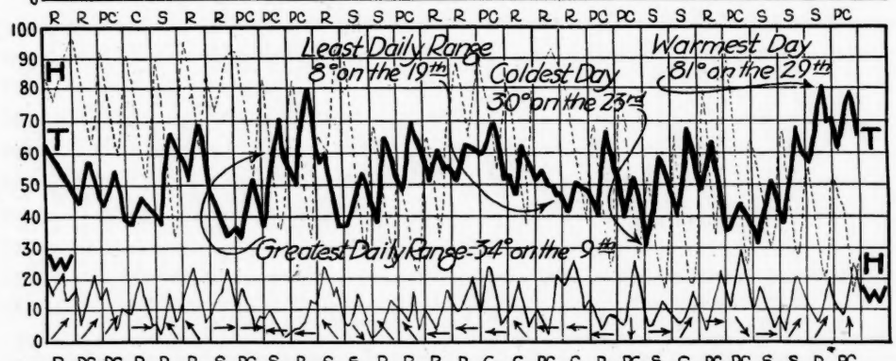
Chicago

Mean temp. for month, 46.8°; aver. wind velocity, 12.3 m.p.h.; prevailing direction of wind, N.E.



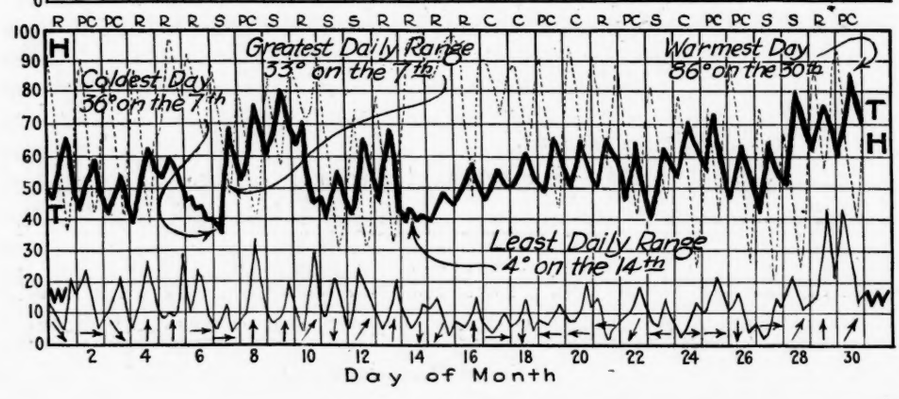
New York

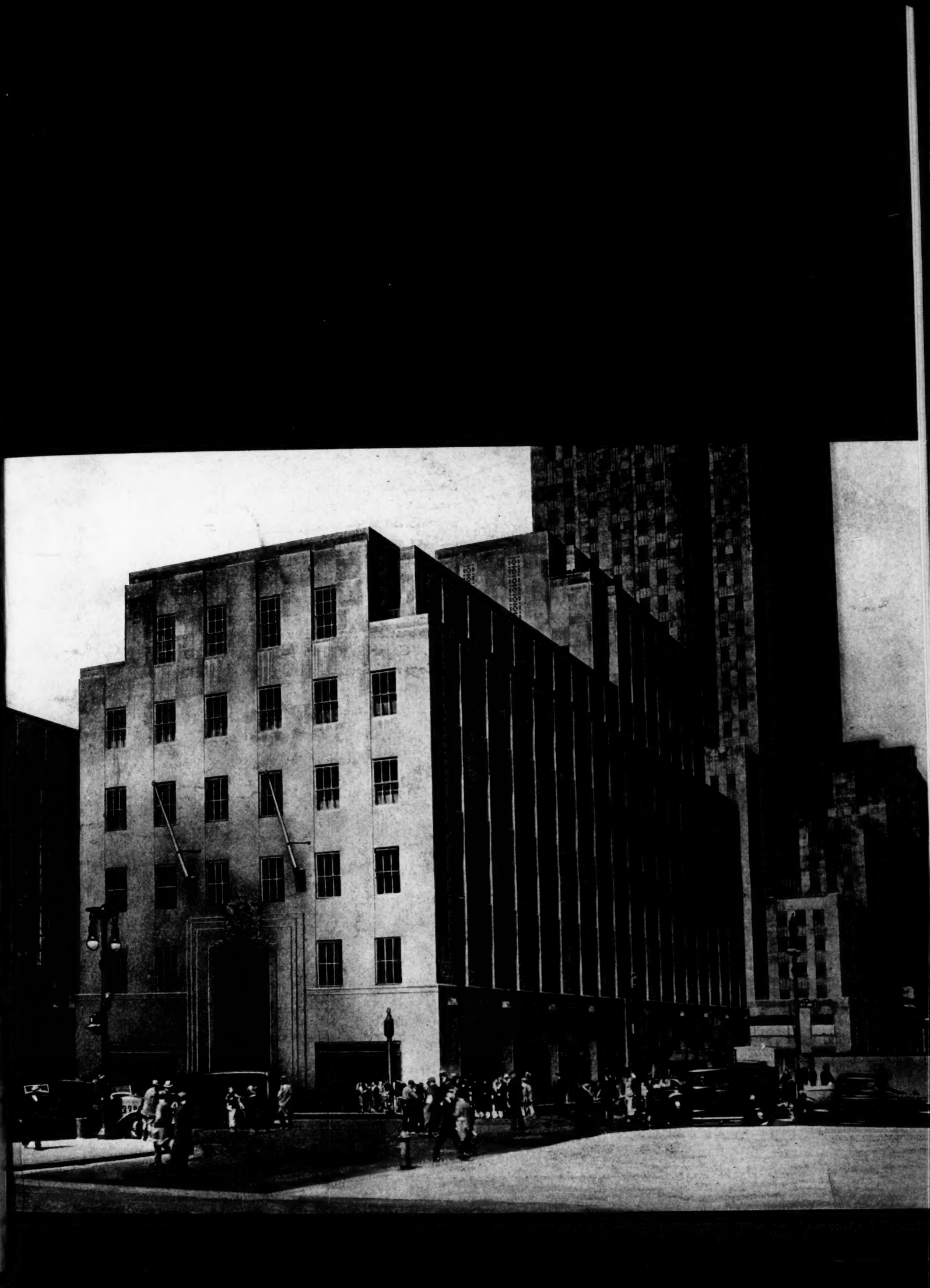
Mean temp. for month, 50.1°; aver. wind velocity, 13.7 m.p.h.; prevailing direction of wind, S.E.



Pittsburgh

Mean temp. for month, 51.6°; aver. wind velocity, 10.4 m.p.h.; prevailing direction of wind, W.


Greatest Daily Range 33° on the 7th
Warmest Day 86° on the 30th
Coldest Day 36° on the 7th
Least Daily Range 4° on the 14th
H
T
W
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Day of Month

St. Louis

Mean temp. for month, 55.5°; aver. wind velocity, 11.2 m.p.h.; prevailing direction of wind, S.